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Vol. XVII, No. 8
August, 1960

INDUSTRIAL QUALITY CONTROL

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The Role of Quality Assurance In Product Reliability, Part II

QUALITY through Scientific Methods

JOURNAL OF THE AMERICAN SOCIETY FOR QUALITY CONTROL

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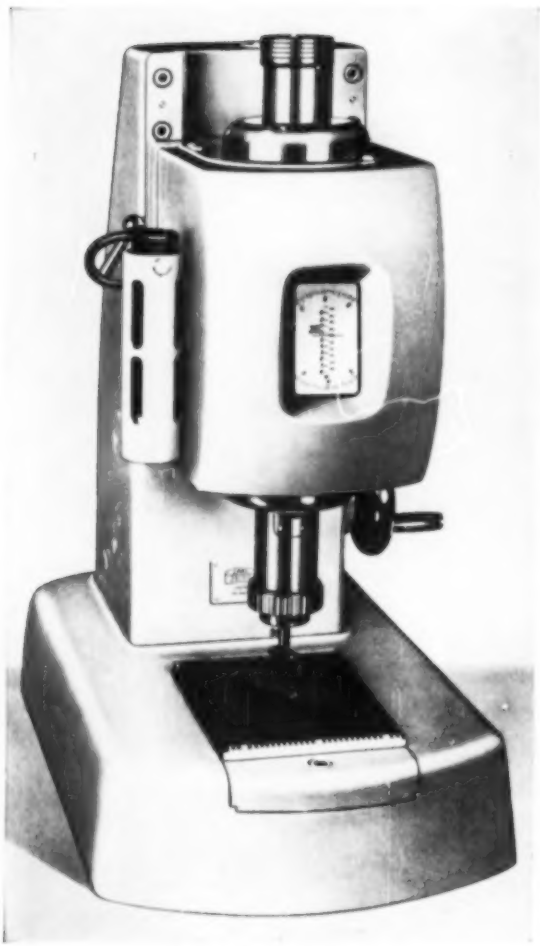

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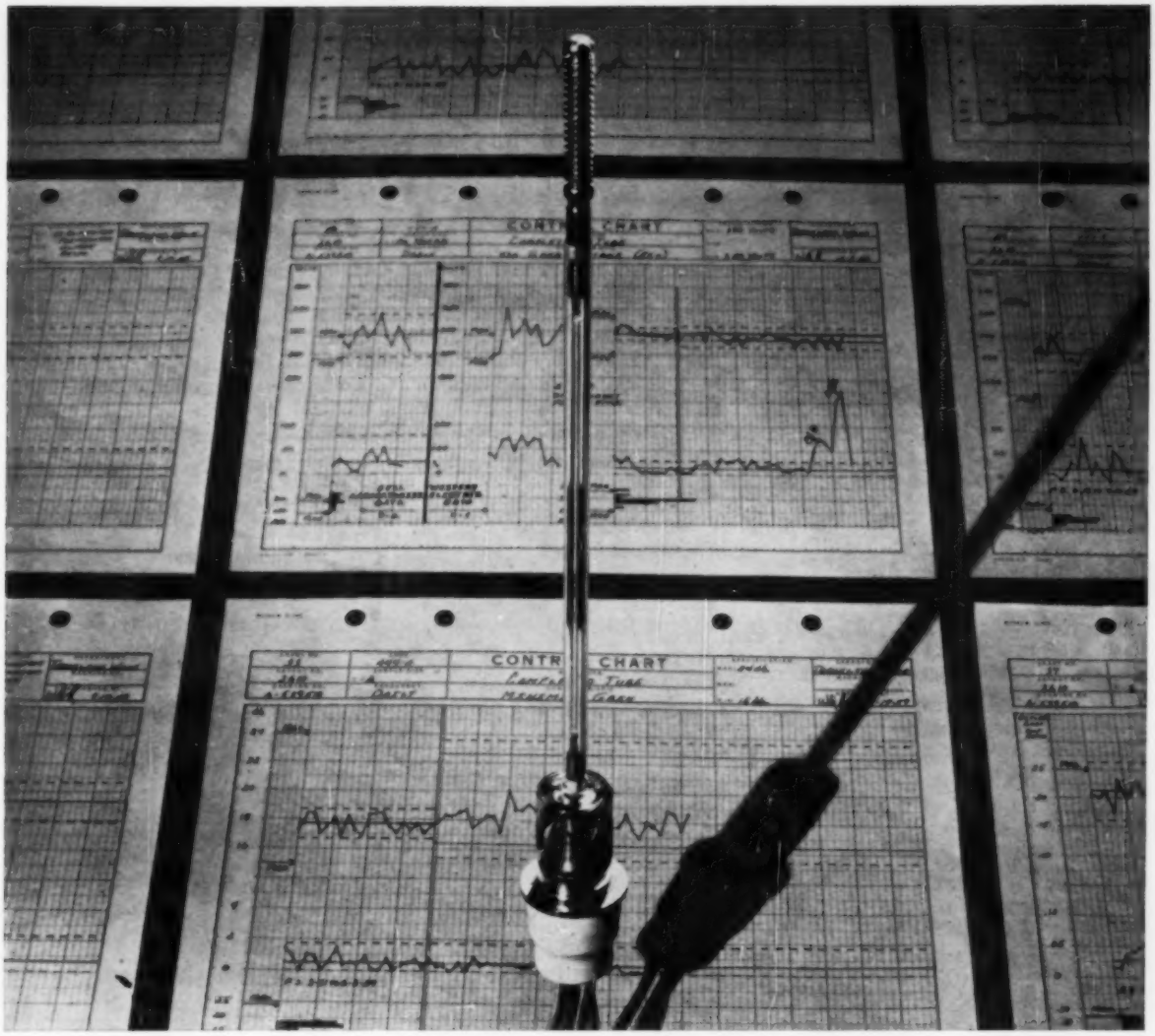

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ARTICLES

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PAUL S. OLMSTEAD **000:00:000**

During the 1960 ASQC Convention and Exhibition May 24-26 in San Francisco, Calif., Mr. Olmstead was awarded the Shewhart Medal for his outstanding service to the science of Quality Control in detecting and clarifying assignable causes. In his acceptance address, "Road to Understanding," Mr. Olmstead attempts to define what we mean by the field of Quality Control in the broadest possible sense.

8 **Eyeball in the Milk Bottle**
AL MILLAR **710:70:437**

Tooling problems encountered in March, 1958, when the Air Force started a program to modify its entire fleet of B-47 medium bombers are discussed by Mr. Millar in this article. The overall B-47 modification project was dubbed Milk Bottle. The project required the manufacture of three special borescopes, which are described in this article.

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This series of articles presents four "popular" procedures for the detection of specific differences existing among a set of k-means in an analysis of variance study, together with a discussion of the merits of each procedure.

17 **A Consolidated Decentralized Reliability and Quality Control Program**
T. E. SMITH **810:10;60;70:438**

The author reviews some of the basic concepts and philosophies which he feels should be common in an effective organization for quality and reliability.

19 **The Role of Quality Assurance in Product Reliability, Part II**
E. G. D. PATERSON **300;800:60;70:400**

In this article, the author outlines the more important ways in which a comprehensive quality assurance program contributes to reliability.

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From the President's Desk

Society Expansion Present and Future

The future of our Society is based on the solid foundation of careful planning and vigorous time-phased action by our officers, directors, divisions, and committees, supported by our energetic National office staff.

The following are indications of the progress being achieved; and things being done to further improve our effectiveness:

Industrial Quality Control, increased by eight pages in the July issue, increases by another eight pages for a total increase of 16 pages beginning with this issue. This is a 40 percent increase in space for additional editorial and article material.

Results of the reader survey will be used as a guide for the types of articles to be published.

Additional expansion (about 30 percent) of leased space for our national office has been accomplished in order to provide more service to our rapidly growing membership. Labor saving equipment is being used to keep our small ASQC office staff one of the most efficient in the nation. In looking to the future, a study is being made to determine the economic feasibility of owning our own "home." Building and operating costs are being studied in several key cities, to permit evaluation.

Our newly activated long-range planning committee, chairmanned by past president Leon Bass, will add much to our stability and direction of effort.

Organizational effectiveness will be increased, and maturity added to our actions, with the completion of a major part of our administrative reorganization by the end of this year. This is being accomplished by the able leadership of past presidents George D. Edwards and C. E. Fisher.

These are only a few of the things being done by our Society, to provide the integrity of service, professional growth, and pride of membership which you and every other member deserve. I will inform you as to our progress on these, and other important matters, during the coming months. Your enthusiastic support of society activities, and helpful suggestions and criticisms, will be welcome.

Jy McClure

Dues are Due September 30 — Today is the Day to Pay

This spring the membership voted to change the "cut-off" date for membership from Oct. 31 to Sept. 30. This means that those members whose dues remain unpaid on Sept. 30, will not receive any further copies of *Industrial Quality Control*. As pointed out above, with this issue the size of your Journal has been increased to 56 pages.

The vote last year also approved the elimination of sending back issues to those members who renew late. To keep your *Industrial Quality Control* coming and to avoid missing any issues, we urge you to pay your dues now.

ROAD TO UNDERSTANDING

PAUL S. OLMSTEAD, *Bell Telephone Laboratories, Whippany, N. J.*

LITTLE did I realize in 1920, when I first met Walter Shewhart, that this would lead to my being designated as the recipient of a medal established in his honor. Now, however, I am deeply conscious of the impact of forty years' association with him. This included a short period as a research physicist, a longer period as a quality assurance engineer, and a still longer period in the application of the concept of an attainable state of statistical control to the solution of research and development problems that have related to both natural and social sciences. I might add that it was the vision of the late Reginald L. Jones, then vice president of the Bell Telephone Laboratories, that was responsible for this extension in the use of statistical methods. It is therefore with more than usual emotion that I indicate to you my extreme pleasure in being designated the Shewhart Medalist for 1959.

To some of you, it may seem that my recent years have been spent in an area that is only marginally related to the major interest of the Society. Perhaps a few of you feel that this area is more typical of operations research or even reliability. Some people outside the Society may feel that the concept of statistical control is relatively useless in this kind of work. Clearly, we in the Society should be able to define what we mean by the field of quality control in the broadest possible sense. With this in mind, I would like you to consider with me a "Road to Understanding", my topic for this evening.

Paul S. Olmstead

ASQC

SHEWHART MEDALIST

For 1959

The desire to explore is inherent in each of us. We are intrigued by the possibility of making a discovery. In traveling an unknown road, the usual thing in research work, we find the going rough at times. Occasionally, we find that we have to retrace our steps because we reach a dead end. In fact, we experience all the troubles that Bunyan described so vividly in "Pilgrim's Progress." Once we reach the goal of understanding, everything seems to fit into place and we are ready to tell others about our trip.

The research worker is apt to describe his process of exploration more formally as the application of scientific method. This assumes that he makes an hypothesis, performs an experiment, and tests his hypothesis. But how does this account for making a discovery? It is only when the test of hypothesis fails that a discovery in the strictest sense of the word is possible.* But how does the research worker know that his test has failed? It seems reasonable that it is only by introducing the concept of statistical control that a satisfactory

*The discussion of discovery in this article is related in a general way to Hadamard's "Essay on the Psychology of Invention in the Mathematical Field."[∞]

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measure of agreement or disagreement with hypothesis would be obtained. Essentially, this is what Shewhart[1] pointed out in his book *Statistical Method from the Viewpoint of Quality Control.*

Expressed in this way, we see many parallels between the apparent need of the research worker for knowledge of statistical control and our own experience. From the time of its founding in 1946, the American Society for Quality Control has advocated statistical control of quality as a primary objective for each member. In spite of this, many of us approached the subject of statistical control as skeptics. Some of us remained skeptics while learning about the mechanics of control charts and acceptance sampling. Even the examples of use seemed so easy that we questioned whether statistical control would be of value in our industry. "Our industry is different" was our common reaction. Nevertheless, a few inquisitive souls did attempt to apply what they had learned. Almost invariably, each became enthused when he found and identified causes of variation that had not been suspected. A veritable "gold rush" followed.

The kinds of causes identified varied greatly from application to application. Some related to manufacturing processes, some to need for specification changes and some to inspection techniques and procedures. In addition to production, applications were made to life testing, consumer acceptance, sales, paper work, and many other areas. Each of us discovered that knowledge of statistical control helped us to find and identify unknown causes of variation.

By sharing our independent observations and discoveries, we broadened our basis for belief that knowledge of statistical control would be expected to help us find and identify other causes in other applications. We were full of the pioneering spirit and anxious to convert all of our friends and acquaintances. The urge to discover was a compelling influence that made us part of a crusade for better quality. The continuing growth of our Society is a tribute to the missionary zeal with which we have shared our experiences with others.

In the early stages of applying what we had learned, we made statistical discoveries almost daily. Then, as our processes became stabilized, our interests turned to quality assurance. This, in spite of its importance, seemed to be devoid of the glamour that was so evident in the discovery phase. A parallel for this area of investigation in research is the statistical evaluation of the constants to be recorded in such publications as the *Smithsonian Physical Tables*[2] or the *International Critical Tables.*[3] The search for the "true value" of a constant is a continuing operation that has resulted in changes from time to time in what has been taken to be the accepted value. Some of the factors that contribute to change are new methods of measurement, more precise measuring equipment, and the like. The search for truth in the physical sciences is unending. At any intermediate step, however, our belief in the "true value" of any constant is related in part to the evidence for statistical control exhibited by the measurements on which it is based. Theoretical grounds for this statement are given in Shewhart's book[1] mentioned previously.

This book was quite pessimistic about the kinds of prediction in which we would care to place a high degree of belief. It would be highest when evidence of statistical control is presented as a basis for the prediction. Otherwise, the most important factors relating to variability are the maximum, minimum, average, and number of measurements. This assumes that no attempts at statistical control have been made. The gap between these two conditions is extremely large and worth exploring. In fact, this is the area that has been a continual challenge to me since 1936 when field performance became my major interest.

A new product was to be tested in the field. It was a new model designed to overcome limitations occasionally reported for the previous design. The questions to be answered were very simple:

1. Will our customers like the new product?
2. What kind of service will we be giving our customers after the new product comes into general use? And
3. How will this compare with the service being given by our present product?

It was important that the answers be equally simple.

With respect to the first question, we were somewhat concerned because all methods of opinion polling had been subject to criticism following the failure of the Literary Digest Poll in 1932. In view of this, we limited our investigation to the recording of unsolicited comments by the customer. To our surprise, comments were received from only about one in ten and these were about equally split between those who liked the product and those who disliked it. When reasons were given for these likes and dislikes, the most common comment received was either, "I like anything new," or "I don't like anything new." The most important finding, of course, was that ninety per cent of the customers had no immediate comment. Obviously, it would be important to see how these reactions would change with use.

Tests in the laboratory had shown that the new product had met the design objectives concerning the improvements desired with respect to the previous product. After they had used the product, most of the customers agreed. However, they also reported unanticipated limitations* that needed attention before the design could be stabilized. Thus, it was obvious at an early stage in the trial that the answers to the questions would have to be postponed until most of the corrective changes were made. In the meantime, attention was given to determining other information that would be useful in planning a new field test to improve the precision of the results and to give assurance that the results would have satisfactory predictive meaning for possible performance in nontest areas.

The final trial was made on the first units of product manufactured to the revised specifications in comparison with an equal number of the regular product. Each irregularity that was encountered in service was identified with respect to its probable occurrence and its association with design, manufacture, installation, or normal life expectancy. Most of the reports identified as belonging to design, manufacture or installation were received within the first three months of use. Experience with other similar products had

*Present development practice often attempts to uncover such limitations through psycho-physical testing, a method of studying the behavior of a consumer as he uses a product[7].

indicated that these could be cut at least in half in our continuing work for improving the product. It remained then to see whether the normal life expectancy items occurred in a manner consistent with hypothesized theory in producing a series of consecutive observations that would meet a criterion of statistical control. Fortunately, this condition was met and the desired answers were obtained.

Some ten years later, after producing 50,000,000 units of this product, we were asked to make a reevaluation. In this case, a sample fifty percent larger was placed on trial in areas widely removed from the previous locations. In comparing the results of the two trials, the findings for each of six component assemblies were within plus and minus three sigma of the original predictions. A seventh component assembly had been changed in structure and was found to give results outside limits by an amount predicted for it from a trial on the component assembly. Taking this difference into account, the old and new findings for the complete product with its seven component assemblies were almost identical and well within the predicted limits of variation. An important additional finding of the new tests was that the types of irregularities attributable to design, manufacture, and installation had all but disappeared.

Reflection on this experience suggested two ways in which it might be possible to close the gap mentioned previously. The first was developed in the article[4] "How to Detect the Type of an Assignable Cause," which appeared in the November 1952 and January 1953 issues of *Industrial Quality Control*. This outlines a way for making statistical discoveries that are worth exploring for the purpose of identifying possible assignable causes. This suggests that any plan for increasing the output of research and development through discovery and invention should include provision for making statistical discoveries. The second relates to making meaningful predictions when a state of statistical control has not been attained but a basis for inferring what it might be can be established from a combination of engineering and statistical considerations. This is discussed in a preliminary way in the Transactions of this Convention under the title, "Statistical Evaluation."[5]

Both of these articles are philosophical in nature. Both were written to outline problems of the engineer and to indicate in a general way what progress has been made toward their solution. Much remains to be done. Part involves unsolved problems in mathematical statistics.[8] Part depends on obtaining a better specification of what the engineer wants to do. It is my firm conviction that once we agree on the assumptions, someone will be able to work out the answers. Nevertheless, we must remember that these answers, though they will add to our knowledge, will then be a new base from which we will continue to make new discoveries.

Many of you will consider this detour into the area of field performance as an alternate path for finding out about limitations that would come to your attention in the investigation of complaints relating to product quality. To this extent, at least, it seems reasonable that performance in service should be included as part of the operation of product control. By agreeing to include performance, we are led to consider the determination of customer wants and the research and development work necessary to meet these wants as two additional parts of the operation of product control. These three parts were added to Shewhart's "specification, production, and inspection" to give the operational view of product quality control pictured in the article in *Industrial Quality Control* mentioned previously. An important feature of this picture was that it drew attention to the discovery and change that is typical of all attempts to reach a state of statistical control. It placed our objective as an "economic state of statistical quality control," a goal that can be assured only by a continuing operation of statistical control that includes each of the component parts just mentioned.

If we are to reach such a goal, each of us must contribute to the maximum of his ability. This means that we must continue to extend our understanding of our various problems. We need more knowledge of statistical methods and the assumptions on which they are based. We need to know more about the natural sciences and their relation to engineering. Above all, we must not forget that people are important and that reaching our goal may depend on what we have learned about psychology, economics, and other subjects often omitted in engineering curricula.

We have traveled but a short distance down our road. Undoubtedly, each of you is thinking now of a turn ahead that may provide a short cut to our goal. You will wish to investigate it and report your findings at some future meeting. If so, such a report is very apt to include a new statistical discovery based on the concept of a state of statistical control. Perhaps it will go farther and provide a statistical evaluation of what appears to be an attainable economic state of statistical quality control. This will be your contribution to providing guideposts on the ROAD TO UNDERSTANDING the unlimited usefulness of the concept of statistical control.

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Eyeball in the Milk Bottle

AL MILLAR, *Tinker Air Force Base, Oklahoma*

Figure 1 — Milk Bottle Hole on B47 Wing Connection

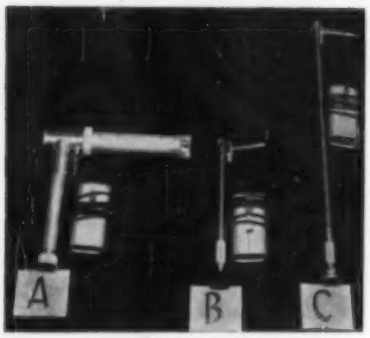

Figure 2—Special Borescopes Designed for the Project Milk Bottle Inspections

During the month of March, 1958, the Air Force started a program to modify its entire fleet of B-47 medium bombers.

This modification presented many tooling problems. Precision machining operations, usually done in a machine shop, had to be accomplished on the aircraft using portable tools. Tool design engineers for the most part solved these problems as they developed. However one problem seemed to defy solution. This problem was the inspection of the internal surfaces of 1200 reamed bolt holes per aircraft.

The overall B-47 modification project was dubbed Milk Bottle. This nickname was derived from the pin which attaches the structural member of the wing to the fuselage. This pin is the size and shape of a milk bottle. Inspection of the milk bottle pin hole was the most critical inspection performed. To inspect the milk bottle hole the first step was to remove a small access panel from the top side of the wing. This exposes a well which has a maze of hoses and cables running through it. Approximately 10 inches down in the wall of the well is the milk bottle hole (see Fig. 1). Then it was necessary to illuminate the hole and look through a magnifying and reflecting device in such a manner that the entire internal surface of the hole could be viewed. One inspector explained, "You have to put your eyeball in the milk bottle."

Standard types of borescopes, industrial mirrors and illuminating magnifiers were used to inspect the holes for shallow cracks caused by metal fatigue. This method of inspection was producing inspector neck and eye fatigue at a rapid rate, as most of the holes to be inspected were directly overhead on the underside of the wing. Others, such as the milk bottle pin hole, were in confined areas where working space and head room were not sufficient to permit the use of borescopes, mirrors or magnifiers, which were available.

Project Milk Bottle got under way at three aircraft plants and two Air Force installations in one week. The project monitors at Headquarters, Oklahoma City Air Materiel Area, were well aware of the fact that all locations working on Project Milk Bottle would encounter the same inspection problems, and they were equally aware that the Air Force could not afford to have B47's on the ground waiting for tools to accomplish the work.

Specifications for special borescopes were prepared immediately and a contracting officer proceeded to contact borescope manufacturers via telephone to negotiate a contract. The magnitude of the

ASQC LCS Code 710:70:437

Figures 3, 4, 5—Use of the Special Borescopes to Inspect Inaccessible Holes

problem became more apparent when after a day and a half had been spent calling borescope manufacturers coast to coast a contract had not been let. It was now Thursday afternoon and several of the first aircraft to be worked on Project Milk Bottle were scheduled for inspection the following Monday. A quick meeting resulted in dispatching an instrument technician to the East Coast to contact borescope manufacturers in person and explain the urgency of the requirement for special borescopes. He arrived in Philadelphia, Pa., early Friday morning and contacted the director of a small optical instrument laboratory. He explained the functions the special borescopes would have to perform and detailed their dimensional limits. The laboratory director developed a schematic diagram of the optical systems of two borescopes which would fulfill the Air Force requirements. A phone call was then placed to Tinker Air Force Base and by 10 a. m. Friday the contract was confirmed and the Philadelphia laboratory was busy making prototypes of the borescopes.

Monday morning at 8 a. m., approximately 72 hours after accepting the contract, the laboratory director arrived at Tinker Air Force Base with the prototypes. He was hustled off to the nearest B47 on which machining operations had been completed. The borescopes worked perfectly. No changes were required; however there were four holes per aircraft which were still hard to reach. A third borescope was designed immediately to facilitate inspection of those holes. Within the week fourteen special borescopes were received by Tinker Air Force Base and the Philadelphia laboratory was flooded with additional orders.

Figure 2 shows the three types of special borescopes used on Project Milk Bottle. Figures 3, 4, and 5 show how they were used. Each borescope has a 6-v illuminating system and four power magnification under normal operating conditions, with a focus adjustment which provided an ideal view of the surface under examination. Borescope "A" was used for inspection of the milk bottle hole (see Fig. 6, Block 4). Indexing lines on the revolving barrel insured the inspector that he had checked the full surface of the hole. Borescope "B" was a truly

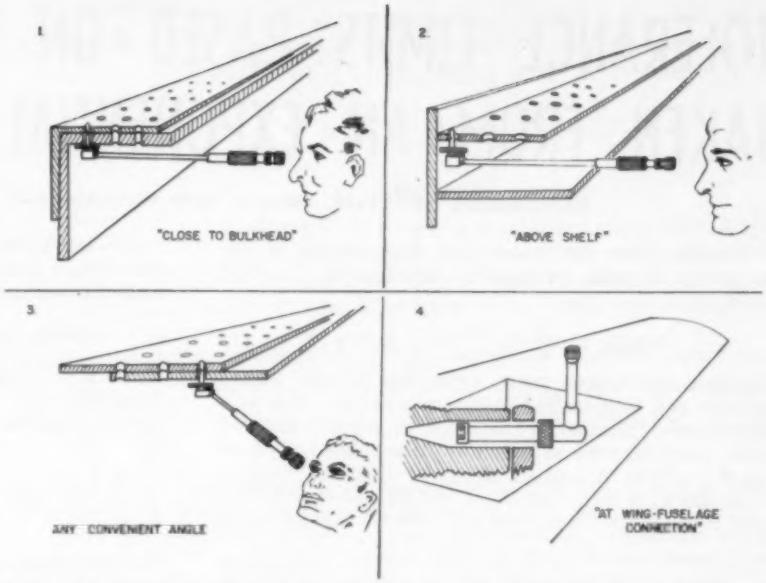

Figure 6—Diagrammatic Sketch of the Types of Inspections that the Borescopes Were Designed To Perform

revolutionary instrument, due to the fact that the two tubes were on a swivel and could be rotated in relation to each other. This feature of the borescope permitted inspection of holes near bulkheads above shelves and in otherwise inaccessible places (see Fig. 6, Blocks 1 and 2). The inspector could turn the tubes to a position which would afford the most comfort, thus relieving inspector neck and eye fatigue (see Fig. 6, Block 3). Borescope "C" was similar to borescope "B", the only difference being the length of one tube. The swivel borescope has become a great favorite among inspectors and will undoubtedly become a standard hole inspection instrument in the aircraft industry.

Defects revealed through borescope inspection can be photographed and integrated into inspection records. Figure 7 is taken deep in the milk bottle pin hole, showing the success achieved in solving this most critical inspection problem.

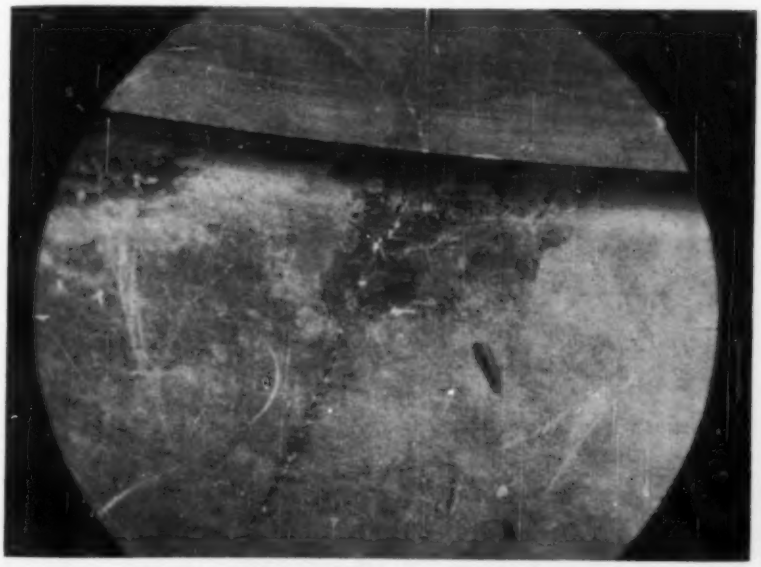

Figure 7—Cracked Milk Bottle Forging Revealed by the Borescope

TOLERANCE LIMITS BASED ON LIFE TEST DATA TAKEN FROM AN EXPONENTIAL DISTRIBUTION*

BENJAMIN EPSTEIN, *Wayne State University and Stanford University*

Suppose that the underlying distribution of life is given by the probability distribution function (p. d. f.)

$$f(x;\theta) = \frac{1}{\theta} e^{-x/\theta} \quad x > 0, \theta > 0 \qquad (1)$$

Suppose that items taken from this lot are placed on test and that testing is discontinued as soon as a preassigned number of failures, r, occur. Let the total life observed in reaching these first r failures be T_r.† Then it can be shown[1] that the random variable T_r is such that $2T_r/\theta$ is distributed as $\chi^2(2r)$ and that a "best" unbiased estimate for θ is given by

$$\hat{\theta} = T_r/r \qquad (2)$$

It also can be shown that a one-sided $100(1-\alpha)$ percent confidence interval for θ is given by

$$\left(\frac{2r\hat{\theta}}{\chi_\alpha^2(2r)}, \infty\right) \text{ or } \left(\frac{2T_r}{\chi_\alpha^2(2r)}, \infty\right) \qquad (3)$$

where $\chi_\alpha^2(2r)$ is the upper α percent point of the $\chi^2(2r)$ distribution.

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†Two important special cases arise when: (a) $n(\geq r)$ items are placed on test at time zero. The test is continued until the first r failures occur, and then it is stopped. Items that fail are not replaced. Let $t_1 \leq t_2 \leq \ldots \leq t_r$ be the first r failure times. Then $T_r = \sum_{i=1}^{r} t_i + (n-r)t_r$; (b) n items are placed on test at time zero. As items fail they are replaced by new items. Testing is stopped as soon as r failures occur. If the failure times are $t_1 \leq t_2 \leq \ldots \leq t_r$, then $T_r = n\,t_r$.

Let us define the quantile x_p as being that life such that a proportion p of the items live for at least time x_p. Accordingly

$$\Pr(X \geq x_p) = p \text{ and } x_p = \theta \log 1/p \qquad (4)$$

if the p. d. f. is given by (1). It then follows at once from (3) that a one-sided $100(1-\alpha)$ percent confidence interval for x_p is given by

$$\left(\frac{2r\,\hat{\theta}\log\frac{1}{p}}{\chi_\alpha^2(2r)}, \infty\right) \text{ or } \left(\frac{2T_r \log\frac{1}{p}}{\chi_\alpha^2(2r)}, \infty\right) \qquad (5)$$

But from the meaning of x_p, (5) can be interpreted as a tolerance interval statement in the sense that we can be $100(1-\alpha)$ percent confident of the assertion that the fraction of items surviving $\tau = 2r\,\hat{\theta}\log(1/p)/\chi_\alpha^2(2r)$ or more time units is $\geq p$.* Let us define

$$K(r, \alpha, p) = 2r \log\left(\frac{1}{p}\right) \Big/ \chi_\alpha^2(2r)$$

Then we can say that the multipliers $K(r, \alpha, p)$ are such that there is probability $(1-\alpha)$ that at least

*For related considerations see Ref. (2). In the terminology of L. A. Goodman in his abstract, Annals of Mathematical Statistics 24, 139, 1953, (5) can be considered a "parameter-free" tolerance limit in the exponential case. In a paper to be published, Goodman and Madansky compare "parameter-free" and "non-parametric" tolerance limits in the exponential case.

TABLE 1(a)—Values of K(r, .01, p) $= 2r \log(1/p)/\chi^2_{.01}(2r)$

r \ p	.50	.75	.90	.95	.99
1	.150	.0624	.0229	.0111	.0022
2	.209	.0866	.0317	.0154	.0030
3	.247	.103	.0376	.0183	.0036
4	.276	.115	.0419	.0204	.0040
5	.299	.124	.0454	.0221	.0043
6	.317	.132	.0483	.0235	.0046
7	.333	.138	.0506	.0246	.0048
8	.347	.144	.0527	.0257	.0050
9	.358	.149	.0545	.0265	.0052
10	.369	.153	.0561	.0273	.0053
11	.378	.157	.0575	.0280	.0055
12	.387	.161	.0588	.0286	.0056
13	.395	.164	.0601	.0292	.0057
14	.402	.167	.0611	.0298	.0058
15	.408	.169	.0621	.0302	.0059
16	.414	.172	.0630	.0307	.0060
17	.420	.174	.0639	.0311	.0061
18	.426	.177	.0647	.0315	.0061
19	.430	.179	.0655	.0319	.0062
20	.435	.181	.0662	.0322	.0063
25	.455	.189	.0692	.0337	.0066
30	.470	.195	.0716	.0348	.0068
40	.493	.205	.0750	.0365	.0071
50	.510	.212	.0776	.0378	.0074
75	.539	.223	.0818	.0398	.0078
100	.556	.231	.0845	.0411	.0080

TABLE 1(b)—Values of K(r, .05, p) $= 2r \log(1/p)/\chi^2_{.05}(2r)$

r \ p	.50	.75	.90	.95	.99
1	.231	.0961	.0352	.0171	.0033
2	.292	.121	.0445	.0216	.0042
3	.330	.137	.0495	.0241	.0048
4	.358	.148	.0544	.0264	.0052
5	.378	.157	.0575	.0280	.C055
6	.396	.164	.0602	.0293	.0057
7	.410	.170	.0623	.0303	.0059
8	.421	.175	.0641	.0312	.0061
9	.432	.180	.0658	.0320	.0062
10	.442	.183	.0671	.0327	.0064
11	.450	.187	.0684	.0333	.0065
12	.457	.190	.0695	.0338	.0066
13	.464	.192	.0705	.0343	.0067
14	.469	.195	.0714	.0347	.0068
15	.475	.197	.0722	.0351	.0069
16	.480	.199	.0730	.0355	.0069
17	.485	.201	.0738	.0359	.0070
18	.489	.203	.0744	.0362	.0071
19	.493	.205	.0750	.0365	.0071
20	.497	.206	.0756	.0368	.0072
25	.514	.213	.0781	.0380	.0074
30	.526	.218	.0800	.0389	.0076
40	.544	.226	.0827	.0403	.0079
50	.557	.231	.0847	.0412	.0080
75	.579	.240	.0880	.0428	.0084
100	.593	.246	.0901	.0439	.0086

TABLE 1(c)—Values of K(r, .10, p) $= 2r \log(1/p)/\chi^2_{.10}(2r)$

r \ p	.50	.75	.90	.95	.99
1	.301	.125	.0457	.0223	.0043
2	.356	.148	.0542	.0264	.0051
3	.391	.162	.0594	.0289	.0056
4	.415	.172	.0631	.0307	.0060
5	.434	.180	.0660	.0321	.0063
6	.448	.186	.0682	.0332	.0065
7	.461	.191	.0701	.0341	.0067
8	.471	.196	.0717	.0349	.0068
9	.480	.199	.0730	.0356	.0069
10	.488	.203	.0742	.0361	.0070
11	.495	.206	.0753	.0366	.0071
12	.501	.208	.0762	.0371	.0072
13	.507	.210	.0770	.0375	.0073
14	.512	.212	.0778	.0379	.0074
15	.516	.214	.0785	.0382	.0075
16	.521	.216	.0792	.0385	.0075
17	.525	.218	.0798	.0388	.0076
18	.529	.220	.0803	.0391	.0076
19	.532	.221	.0808	.0393	.0077
20	.535	.222	.0814	.0396	.0077
25	.549	.228	.0835	.0406	.0079
30	.559	.232	.0850	.0413	.0081
40	.574	.238	.0873	.0425	.0083
50	.585	.243	.0890	.0433	.0084
75	.602	.250	.0916	.0446	.0087
100	.613	.255	.0933	.0454	.0089

100p percent of the population has life exceeding $K(r, \alpha, p)\hat{\theta}_{r,n}$. In Table I we give the values of $K(r, \alpha, p)$ for

$$r = 1(1)20(5)30(10)50(25)100$$
$$\alpha = 0.01, 0.05, 0.10, 0.20, 0.25, 0.50$$
$$p = 0.50, 0.75, 0.90, 0.95, 0.99$$

We have just considered a situation where life testing is discontinued after a preassigned number of failures, r, have occurred. In this case T_r, the observed total life, is a random variable. Another very frequent situation is where life testing is discontinued after a preassigned total life T^*.† In this case it is readily shown that a one-sided $100(1 - \alpha)$ percent confidence interval for θ is given by

$$\left(\frac{2T^*}{\chi_\alpha^2(2r + 2)} , \infty \right) \qquad (6)$$

where r is the observed number of items failing in total life T^*. It is readily verified that r is a Poisson random variable with $\lambda = T^*/\theta$. If we define $\tilde{\theta}$ as $\tilde{\theta} = T^*/r + 1$, then (6) can be rewritten as

$$\left(\frac{2(r + 1)\tilde{\theta}}{\chi_\alpha^2(2r + 2)} , \infty \right) \qquad (7)$$

Similarly one-sided $100(1 - \alpha)$ percent confidence intervals for x_p are given by

$$\left(\frac{2(r + 1)\tilde{\theta} \log \frac{1}{p}}{\chi_\alpha^2(2r + 2)} , \infty \right) \qquad (8)$$

By analogy with what was said earlier, there is probability $(1 - \alpha)$ that at least 100p percent of the population has life exceeding $K(r + 1, \alpha, p)\tilde{\theta}$. Thus if r failures are observed we take the appropriate value of K corresponding to $(r + 1)$, *i.e.*,

$$K = 2(r + 1) \log\left(\frac{1}{p}\right) / \chi_\alpha^2(2r + 2) \qquad (9)$$

†The most important special case is when n items are placed on test, are replaced as they fail, and where testing is stopped after time t^*. In this case the total life is $T^* = nt^*$.

Numerical Examples

Problem 1. A life test is carried out until five failures occur. This takes a total life of 5000 hours. Find that value τ such that we can have 95 percent confidence that at least 90 percent of the items survive τ hours.

Solution: $\hat{\theta} = T_r/r = 5000/5 = 1000$. According to our notation, $\alpha = 0.05$ and $p = 0.90$. The associated $K(5, 0.05, 0.90) = 0.0575$. Thus $\tau = K\hat{\theta} = 1000(0.0575) = 57.5$ hours.

Problem 2. A life test is carried out until the total observed life is 1000 hours. The test is then discontinued. Exactly one failure occurs. Find that value τ such that we can have 90 percent confidence that at least 50 percent of the items survive τ hours.

Solution: $\tilde{\theta} = T/r + 1 = 1000/2 = 500$. According to our notation, $\alpha = 0.10$ and $p = 0.50$. Therefore, $\tau = K(r + 1, \alpha, p)\tilde{\theta} = K(2, 0.10, 0.50)\ (500) = (0.356)(500) = 178$ hours.

References

1. B. Epstein and M. Sobel, "Life Testing," *Journal of the American Statistical Association*, 48, 486-502 (1953)
2. A. Madansky, "Use of Tolerance Limits in Missile Evaluation," *Proceedings of the Virginia Polytechnic Institute Symposium on Statistical Techniques in Missile Evaluation*, 43-52, (1958).

TABLE 1(d)—Values of K(r, .20, p) = 2r log (1/p)/$\chi^2_{.20}$(2r)

r \ p	.50	.75	.90	.95	.99
1	.430	.179	.0655	.0319	.0062
2	.463	.192	.0704	.0343	.0067
3	.486	.202	.0739	.0360	.0070
4	.502	.209	.0764	.0372	.0073
5	.516	.214	.0784	.0382	.0074
6	.528	.218	.0800	.0389	.0076
7	.534	.222	.0813	.0396	.0077
8	.542	.225	.0824	.0401	.0078
9	.548	.228	.0834	.0406	.0079
10	.554	.230	.0842	.0410	.0080
11	.559	.232	.0850	.0413	.0081
12	.563	.234	.0856	.0417	.0081
13	.567	.235	.0862	.0420	.0082
14	.570	.237	.0867	.0422	.0082
15	.574	.238	.0873	.0425	.0083
16	.577	.239	.0877	.0427	.0083
17	.579	.241	.0881	.0429	.0084
18	.582	.242	.0885	.0431	.0084
19	.584	.243	.0889	.0432	.0084
20	.586	.243	.0892	.0434	.0085
25	.596	.247	.0906	.0441	.0086
30	.603	.250	.0917	.0446	.0087
40	.613	.255	.0933	.0454	.0089
50	.621	.258	.0944	.0460	.0090
75	.633	.263	.0962	.0468	.0091
100	.640	.266	.0973	.0473	.0092

TABLE 1(e)—Values of K(r, .25, p) = 2r log (1/p)/$\chi^2_{.25}$(2r)

r \ p	.50	.75	.90	.95	.99
1	.500	.207	.0760	.0370	.0072
2	.515	.214	.0783	.0381	.0074
3	.530	.220	.0806	.0392	.0077
4	.543	.225	.0825	.0402	.0078
5	.552	.229	.0840	.0409	.0080
6	.560	.232	.0852	.0415	.0081
7	.567	.235	.0862	.0420	.0082
8	.573	.238	.0871	.0424	.0083
9	.577	.240	.0878	.0427	.0083
10	.582	.241	.0884	.0430	.0084
11	.585	.243	.0891	.0433	.0085
12	.589	.245	.0896	.0436	.0085
13	.592	.246	.0900	.0438	.0085
14	.595	.247	.0904	.0440	.0086
15	.597	.248	.0908	.0442	.0086
16	.600	.249	.0912	.0444	.0087
17	.602	.250	.0916	.0446	.0087
18	.604	.251	.0919	.0447	.0087
19	.606	.251	.0921	.0448	.0087
20	.608	.252	.0924	.0450	.0088
25	.615	.255	.0936	.0456	.0089
30	.621	.258	.0944	.0460	.0090
40	.629	.261	.0957	.0466	.0091
50	.635	.264	.0965	.0470	.0092
75	.645	.268	.0980	.0477	.0093
100	.651	.270	.0990	.0482	.0094

TABLE 1(f)—Values of K(r, .50, p) = 2r log (1/p)/$\chi^2_{.50}$(2r)

r \ p	.50	.75	.90	.95	.99
1	1.000	.415	.152	.0740	.0144
2	.826	.343	.126	.0611	.0119
3	.778	.323	.118	.0576	.0112
4	.755	.313	.115	.0559	.0109
5	.742	.308	.113	.0549	.0107
6	.733	.304	.112	.0543	.0106
7	.728	.302	.111	.0539	.0105
8	.723	.300	.110	.0535	.0104
9	.719	.299	.109	.0532	.0104
10	.717	.297	.109	.0530	.0103
11	.715	.297	.109	.0529	.0103
12	.713	.296	.108	.0527	.0103
13	.711	.295	.108	.0526	.0103
14	.710	.295	.108	.0525	.0102
15	.709	.294	.108	.0524	.0102
16	.708	.294	.108	.0524	.0102
17	.707	.293	.108	.0523	.0102
18	.706	.293	.107	.0523	.0102
19	.706	.293	.107	.0522	.0102
20	.705	.293	.107	.0522	.0102
25	.702	.291	.107	.0520	.0101
30	.701	.291	.107	.0519	.0101
40	.699	.290	.106	.0517	.0101
50	.698	.290	.106	.0517	.0101
75	.696	.289	.106	.0515	.0101
100	.695	.289	.106	.0515	.0101

LINEAR CONTRASTS

PART II

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IN PART I, the subject of linear contrasts was introduced.* Also, discussed and illustrated were orthogonal contrasts and the procedure developed by Henry Scheffe[5]. In this paper methods suggested by David B. Duncan[2,3,4] and John W. Tukey[7,8] are presented and examples given.

An additional linear contrasts procedure and a discussion of the relative merits of the given techniques will constitute Part III.

The Method of David B. Duncan

As indicated above, Duncan (since his Doctoral dissertation)[1] has been vitally interested in this problem of isolating significant effects in an experiment. His latest paper[4] is on a highly theoretical plane, but of considerable interest to those with the necessary mathematical maturity. Since it is the purpose of this series of articles to provide the practitioner with useful tools, we shall direct our attention to the multiple range test[3].

Duncan's test is analogous to Student's t test for detecting significance when only a pair of sample means are involved. However, as the number of means in a group increases, Duncan's test requires a greater difference to detect significances between extremes.

The mathematical procedure for the test follows. The sample means (all based on n observations) are ranked in order, from lowest to highest. The standard error for a single mean is computed by taking the square root of the ratio of the residual mean square (denominator mean square in F ratio giving significance) to n, namely:

$$S_{\bar{x}} = [\text{ residual mean square} \div n\ ]^{1/2} \qquad (1)$$

If only two samples were involved, say at the 0.05 level, the mean difference would be significant if

$$| \bar{x}_1 - \bar{x}_2 | > t\, S_{\bar{x}} \sqrt{2} \qquad (2)$$

where t is Student's "t" value for $2(n-1)$ degrees of freedom. $t\sqrt{2}\,S_{\bar{x}}$ is referred to as the least significant difference, or L.S.D. For example, if there were 10 observations in each sample, the appropriate t value for 18 degrees of freedom at the 0.05 level would be 2.101. When multiplied by $\sqrt{2}$, this gives

$$| \bar{x}_1 - \bar{x}_2 | > 2.97\, S_{\bar{x}} \qquad (3)$$

This value of 2.97 may also be found in Table I in the column headed $k = 2$ and the row $n_2 = 18$. All the values in this first column, in fact, correspond to student's "t" values multiplied by $\sqrt{2}$. Table II gives the corresponding 0.01 values.

In these two tables, k represents the number of means in the factor under study and n_2 corresponds to the degrees of freedom associated with the residual mean square in the analysis of variance table. The entries in the body of this table are designated r_k and when multiplied by $S_{\bar{x}}$ are designated as R_k.

In general, then, two means are called significant at a given α-level, if

$$| \bar{x}_k - \bar{x}_1 | > r_k\, S_{\bar{x}}$$

or

$$| \bar{x}_k - \bar{x}_1 | > R_k \qquad (4)$$

That is, the two extreme means in a set of 5 are significantly different, provided

$$| \bar{x}_5 - \bar{x}_1 | > r_5\, S_{\bar{x}} = R_5 \qquad (5)$$

R_k may be referred to as the shortest significant range. Duncan[3] states "Each difference is significant if it exceeds the corresponding shortest significant range; otherwise, it is not significant." The *exception* to this rule states: "No difference between two means can be declared significant if the two means concerned are both contained in a subset of means which has a nonsignificant range." This latter

ASQC LCS Code 523:00:000

*Part I was published in the July, 1960, issue of *Industrial Quality Control*.

Table I—Significant Ranges for a 5 Percent Level New* Multiple Range Test

n_2 \ k	2	3	4	5	6	7	8	9	10	12	14	16	18	20	50	100
1	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
2	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09
3	4.50	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52	4.52
4	3.93	4.01	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03	4.03
5	3.64	3.75	3.80	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81	3.81
6	3.46	3.59	3.65	3.68	3.69	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70
7	3.34	3.48	3.55	3.59	3.61	3.62	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63
8	3.26	3.40	3.47	3.52	3.55	3.57	3.58	3.56	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
9	3.20	3.34	3.42	3.47	3.50	3.52	3.54	3.54	3.54	3.55	3.55	3.55	3.55	3.55	3.55	3.55
10	3.15	3.29	3.38	3.43	3.46	3.49	3.50	3.52	3.52	3.53	3.53	3.53	3.53	3.53	3.53	3.53
11	3.11	3.26	3.34	3.40	3.43	3.46	3.48	3.49	3.50	3.51	3.51	3.51	3.51	3.51	3.51	3.51
12	3.08	3.23	3.31	3.37	3.41	3.44	3.46	3.47	3.48	3.50	3.50	3.50	3.50	3.50	3.50	3.50
13	3.06	3.20	3.29	3.35	3.39	3.42	3.44	3.46	3.47	3.48	3.49	3.49	3.49	3.49	3.49	3.49
14	3.03	3.18	3.27	3.33	3.37	3.40	3.43	3.44	3.46	3.47	3.48	3.48	3.48	3.48	3.48	3.48
15	3.01	3.16	3.25	3.31	3.36	3.39	3.41	3.43	3.45	3.46	3.48	3.48	3.48	3.48	3.48	3.48
16	3.00	3.14	3.23	3.30	3.34	3.38	3.40	3.42	3.44	3.46	3.47	3.48	3.48	3.48	3.48	3.48
17	2.98	3.13	3.22	3.28	3.33	3.37	3.39	3.41	3.43	3.45	3.46	3.47	3.48	3.48	3.48	3.48
18	2.97	3.12	3.21	3.27	3.32	3.36	3.38	3.40	3.42	3.44	3.46	3.47	3.47	3.47	3.47	3.47
19	2.96	3.11	3.20	3.26	3.31	3.35	3.37	3.40	3.41	3.44	3.46	3.47	3.47	3.47	3.47	3.47
20	2.95	3.10	3.19	3.25	3.30	3.34	3.37	3.39	3.41	3.44	3.45	3.46	3.47	3.47	3.47	3.47
24	2.92	3.07	3.16	3.23	3.28	3.31	3.34	3.37	3.39	3.42	3.44	3.46	3.46	3.47	3.47	3.48
30	2.89	3.04	3.13	3.20	3.25	3.29	3.32	3.35	3.37	3.40	3.43	3.45	3.46	3.47	3.49	3.49
40	2.86	3.01	3.10	3.17	3.22	3.27	3.30	3.33	3.35	3.39	3.42	3.44	3.46	3.47	3.50	3.50
60	2.83	2.98	3.07	3.14	3.20	3.24	3.28	3.31	3.33	3.37	3.41	3.43	3.45	3.47	3.54	3.54
120	2.80	2.95	3.05	3.12	3.17	3.22	3.25	3.29	3.31	3.36	3.39	3.42	3.45	3.47	3.58	3.60
∞	2.77	2.92	3.02	3.09	3.15	3.19	3.23	3.26	3.29	3.34	3.38	3.41	3.44	3.47	3.64	3.73

*Using special protection levels based on degrees of freedom.

statement implies that, if we rank 5 means and find that the difference between extremes is not significant, no other means can be declared significantly different from each other.

A simple way to proceed is best illustrated by some data obtained in a taste-testing experiment with which the author was associated. For proprietary reasons the data have been coded and identified only by letter. Seven treatments were presented to a group of judges in a three-factor plus a single nesting design. The F ratio for treatment effects was 8.32. When compared to the 0.05 Table F (2.17) at 6 and 132 degrees of freedom, we see obvious significance. The residual (denominator) mean square is 0.59 and is based on 132 degrees of freedom. The first step is to compute the standard error of a mean. In this case, since each mean was based on 39 observations, the standard error is,

$$S_{\bar{x}} = \left\{\frac{.59}{39}\right\}^{1/2} = 0.12$$

Next, the treatment means are ranked from lowest to highest. We have the rankings given below:

Treatment	D	C	E	B	F	G	A
Mean	1.85	1.87	2.03	2.13	2.26	2.64	2.74

Since we can compare means which are adjacent ($k = 2$) to means which include all seven ($k = 7$),

Table II—Significant Ranges for a 1 Percent Level New* Multiple Range Test

n_2 \ k	2	3	4	5	6	7	8	9	10	12	14	16	18	20	50	100
1	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
3	8.26	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32
4	6.51	6.68	6.74	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.76
5	5.70	5.89	5.99	6.04	6.06	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07
6	5.24	5.44	5.55	5.61	5.65	5.68	5.69	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70
7	4.95	5.14	5.26	5.33	5.38	5.42	5.44	5.45	5.46	5.47	5.47	5.47	5.47	5.47	5.47	5.47
8	4.75	4.94	5.06	5.13	5.19	5.23	5.26	5.28	5.29	5.31	5.32	5.32	5.32	5.32	5.32	5.32
9	4.60	4.79	4.91	4.99	5.04	5.09	5.12	5.14	5.16	5.18	5.20	5.20	5.21	5.21	5.21	5.21
10	4.48	4.67	4.79	4.87	4.93	4.97	5.01	5.04	5.06	5.09	5.11	5.12	5.12	5.14	5.14	5.14
11	4.39	4.58	4.70	4.78	4.84	4.89	4.92	4.95	4.97	5.01	5.03	5.04	5.05	5.06	5.06	5.06
12	4.32	4.50	4.62	4.71	4.77	4.81	4.85	4.88	4.91	4.94	4.97	4.99	5.00	5.01	5.01	5.01
13	4.26	4.44	4.56	4.64	4.71	4.75	4.79	4.82	4.85	4.89	4.92	4.94	4.95	4.96	4.97	4.97
14	4.21	4.39	4.51	4.59	4.65	4.70	4.74	4.77	4.80	4.84	4.87	4.89	4.91	4.92	4.94	4.94
15	4.17	4.35	4.46	4.55	4.61	4.66	4.70	4.73	4.76	4.80	4.83	4.86	4.87	4.89	4.91	4.91
16	4.13	4.31	4.42	4.51	4.57	4.62	4.66	4.70	4.72	4.77	4.80	4.82	4.84	4.86	4.89	4.89
17	4.10	4.27	4.39	4.47	4.54	4.59	4.63	4.66	4.69	4.74	4.77	4.80	4.82	4.83	4.87	4.87
18	4.07	4.25	4.36	4.44	4.51	4.56	4.60	4.63	4.66	4.71	4.74	4.77	4.79	4.81	4.86	4.86
19	4.05	4.22	4.33	4.42	4.48	4.53	4.57	4.61	4.64	4.69	4.72	4.75	4.77	4.79	4.84	4.84
20	4.02	4.20	4.31	4.39	4.45	4.51	4.55	4.59	4.62	4.66	4.70	4.73	4.75	4.80	4.83	4.83
24	3.96	4.13	4.24	4.32	4.39	4.44	4.48	4.52	4.55	4.60	4.63	4.66	4.69	4.71	4.80	4.80
30	3.89	4.06	4.17	4.25	4.31	4.37	4.41	4.44	4.48	4.53	4.57	4.60	4.63	4.65	4.77	4.78
40	3.82	3.99	4.10	4.18	4.24	4.30	4.34	4.38	4.41	4.46	4.50	4.54	4.57	4.59	4.74	4.76
60	3.76	3.99	4.03	4.11	4.17	4.23	4.27	4.31	4.34	4.39	4.44	4.47	4.50	4.53	4.71	4.76
120	3.70	3.86	3.96	4.04	4.11	4.16	4.20	4.24	4.27	4.33	4.37	4.41	4.44	4.47	4.67	4.77
∞	3.64	3.80	3.90	3.98	4.04	4.09	4.13	4.17	4.20	4.26	4.31	4.34	4.38	4.41	4.63	4.78

*Using special protection levels based on degrees of freedom.

Table III—Shortest Significant Ranges by Duncan's Procedure

k	r_k	R_k
2	2.20	0.34
3	2.95	0.35
4	3.05	0.37
5	3.12	0.37
6	3.18	0.38
7	3.22	0.39

we now set up Table III to establish the minimum differences in treatment means necessary for significance. In this table, k is the number of means in the range of means being compared; r_k is the approximate term from Table I for given values of k and the associated degrees of freedom for the residual mean square; and, $R_k = r_k S_{\bar{x}}$. Since the

Table IV—Differences Among Means for Seven Treatments in Taste Test Study

Treatment	C	E	B	F	G	A
D	0.02	0.18	0.28	0.41*	0.79*	0.89*
C		0.16	0.26	0.39	0.77*	0.87*
E			0.10	0.23	0.61*	0.71*
B				0.13	0.51*	0.61*
F					0.38*	0.48*
G						0.10

accompanying tables do not have 132 degrees of freedom for n_2, 100 degrees of freedom were used.

Many devices have been suggested for ascertaining which mean differences are significant for the R_k values given above. Two methods are given below*.

The first of these involves setting up a triangular table of differences among all means of the given factor. Table IV presents these differences. The row-column intersection indicates the amount by which the two treatment means differ. For example, treatment B (2.13) and treatment G(2.64) differ by 0.51. This number is found in the column headed G and the row labelled B. The advantage of this table is evident when we note that all terms on the main diagonal represent the differences between adjacent treatment means (k = 2); all teams just above the main diagonal represent differences between treatment means which are separated by a single treatment (k = 3); and so on. This simplifies the problem of detecting significances. Any position on the main diagonal which exceeds 0.34 (from Table III for k = 2) is significant at the 0.05 level. Only treatments F and G are significant adjacent means. Any position just above the main diagonal which exceeds 0.35 (from Table III for k = 3) is significant at 0.05. Here, 0.51 and 0.48 are significant. In a similar way other treatment mean differences are compared and asterisks (*) inserted in Table IV wherever significance does exist.

Utilizing this technique requires that all 21 mean differences be computed. A suggested alternative involves comparing means until nonsignificance occurs. This will decrease the number of differences necessary but requires a careful routine. The author has found the steps following Table IV to be useful.

1. Compare D with A, C with A, E with A, etc., until the first nonsignificance occurs; then stop. (Care must be exercised in comparing the computed mean differences to the appropriate R_k values in Table III.) Since the treatment D versus Treatment A comparison involves 7 means, $R_7 = 0.39$ must be exceeded for significance. Treatment C versus treatment A involves 6 means; hence, $R_6 = 0.38$ is required for significance. In this step, only G and A are found to be nonsignificant.

2. Compare D with G, C with G, etc., until the first nonsignificance occurs. Here G is significantly different from the first five treatments.

3. Compare D with F, C with F, etc., until a lack of significance occurs. C and F are not significant. By Duncan's exception rule, we need not test E and F, and B and F since E and B are automatically classified as not significantly different from F.

4. These comparisons continue until all necessary treatment means differences have been computed.

*The author is indebted to the referee for sending him a set of mimeographed notes in which the first of these methods is presented.

Table VI—Upper 5 Percent Points of the Studentized Range, q

n_2/k	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	18.0	27.0	32.8	37.1	40.4	43.1	45.4	47.4	49.1	50.6	52.0	53.2	54.3	55.4	56.3	57.2	58.0	58.8	59.6
2	6.09	8.3	9.8	10.9	11.7	12.4	13.0	13.5	14.0	14.4	14.7	15.1	15.4	15.7	15.9	16.1	16.4	16.6	16.8
3	4.50	5.91	6.82	7.50	8.04	8.48	8.85	9.18	9.46	9.72	9.95	10.15	10.35	10.52	10.69	10.84	10.98	11.11	11.24
4	3.93	5.04	5.76	6.29	6.71	7.05	7.35	7.60	7.83	8.03	8.21	8.37	8.52	8.66	8.79	8.91	9.03	9.13	9.23
5	3.64	4.60	5.22	5.67	6.03	6.33	6.58	6.80	6.99	7.17	7.32	7.47	7.60	7.72	7.83	7.93	8.03	8.12	8.21
6	3.46	4.34	4.90	5.31	5.63	5.89	6.12	6.32	6.49	6.65	6.79	6.92	7.03	7.14	7.24	7.34	7.43	7.51	7.59
7	3.34	4.16	4.68	5.06	5.36	5.61	5.82	6.00	6.16	6.30	6.43	6.55	6.66	6.76	6.85	6.94	7.02	7.09	7.17
8	3.26	4.04	4.53	4.89	5.17	5.40	5.60	5.77	5.92	6.05	6.18	6.29	6.39	6.48	6.57	6.65	6.73	6.80	6.87
9	3.20	3.95	4.42	4.76	5.02	5.24	5.43	5.60	5.74	5.87	5.98	6.09	6.19	6.28	6.36	6.44	6.51	6.58	6.64
10	3.15	3.88	4.33	4.65	4.91	5.12	5.30	5.46	5.60	5.72	5.83	5.93	6.03	6.11	6.20	6.27	6.34	6.40	6.47
11	3.11	3.82	4.26	4.57	4.82	5.03	5.20	5.35	5.49	5.61	5.71	5.81	5.90	5.99	6.06	6.14	6.20	6.26	6.33
12	3.08	3.77	4.20	4.51	4.75	4.95	5.12	5.27	5.40	5.51	5.62	5.71	5.80	5.88	5.95	6.03	6.09	6.15	6.21
13	3.06	3.73	4.15	4.45	4.69	4.88	5.05	5.19	5.32	5.43	5.53	5.63	5.71	5.79	5.86	5.93	6.00	6.05	6.11
14	3.03	3.70	4.11	4.41	4.64	4.83	4.99	5.13	5.25	5.36	5.46	5.55	5.64	5.72	5.79	5.85	5.92	5.97	6.03
15	3.01	3.67	4.08	4.37	4.60	4.78	4.94	5.08	5.20	5.31	5.40	5.49	5.58	5.65	5.72	5.79	5.85	5.90	5.96
16	3.00	3.65	4.05	4.33	4.56	4.74	4.90	5.03	5.15	5.26	5.35	5.44	5.52	5.59	5.66	5.72	5.79	5.84	5.90
17	2.98	3.63	4.02	4.30	4.52	4.71	4.86	4.99	5.11	5.21	5.31	5.39	5.47	5.55	5.61	5.68	5.74	5.79	5.84
18	2.97	3.61	4.00	4.28	4.49	4.67	4.82	4.96	5.07	5.17	5.27	5.35	5.43	5.50	5.57	5.63	5.69	5.74	5.79
19	2.96	3.59	3.98	4.25	4.47	4.65	4.79	4.92	5.04	5.14	5.23	5.32	5.39	5.46	5.53	5.59	5.65	5.70	5.75
20	2.95	3.58	3.96	4.23	4.45	4.62	4.77	4.90	5.01	5.11	5.20	5.28	5.36	5.43	5.49	5.55	5.61	5.66	5.71
24	2.92	3.53	3.90	4.17	4.37	4.54	4.68	4.81	4.92	5.01	5.10	5.18	5.25	5.32	5.38	5.44	5.50	5.54	5.59
30	2.89	3.49	3.84	4.10	4.30	4.46	4.60	4.72	4.83	4.92	5.00	5.08	5.15	5.21	5.27	5.33	5.38	5.43	5.48
40	2.86	3.44	3.79	4.04	4.23	4.39	4.52	4.63	4.74	4.82	4.91	4.98	5.05	5.11	5.16	5.22	5.27	5.31	5.36
60	2.83	3.40	3.74	3.98	4.16	4.31	4.44	4.55	4.65	4.73	4.81	4.88	4.94	5.00	5.06	5.11	5.16	5.20	5.24
120	2.80	3.36	3.69	3.92	4.10	4.24	4.36	4.48	4.56	4.64	4.72	4.78	4.84	4.90	4.95	5.00	5.05	5.09	5.13
∞	2.77	3.31	3.63	3.86	4.03	4.17	4.29	4.39	4.47	4.55	4.62	4.68	4.74	4.80	4.85	4.89	4.93	4.97	5.01

k is the number of quantities (e.g., means) whose range is involved.
n_2 is the degrees of freedom in the error estimate.

Once all comparisons have been tested, it is important to summarize the significant results to facilitate interpretations. One approach which is fairly popular is to underline those means which are not significantly different from each other. In effect, then, statistically homogeneous groups are indicated. Table V utilizes this summary technique for the taste test data.

Table V—Significant Treatment Differences for Taste Test Data

Treatment	D	C	E	B	F	G	A
Mean	1.85	1.87	2.03	2.13	2.26	2.64	2.74

Underlined means are not significantly different at the 0.05 level. For example, Treatment F does not differ significantly from C, but it does differ from D, G, and A.

This, then, constitutes Duncan's multiple range test.

The Method of John W. Tukey

In References (7), (8), and (9) John Tukey indicates his interest in the problems of comparing individual means in the analysis of variance. Although the technique presented in (7) is of considerable interest, the author chooses here to illustrate the method involving the studentized range [mentioned in (5), page 91 and in (6) and (10)].

This technique involves computing a quantity called WSD (wholly significant difference). This quantity [comparable to the LSD, (least significant difference), given in equation (2)] is then used as the criterion for stating that a given contrast is significant. Tables VI and VII are necessary for this method.

The steps follow:

1. The standard error of a mean is computed [as in (1) above], namely,

$$S \div \sqrt{n} = S_{\bar{x}} \qquad (6)$$

where S is the square root of the residual mean square in the analysis of variance table and is based on n_2 degrees of freedom, and n is the number of observations involved in a single mean.

2. The entries in Tables VI and VII are referred to as q_k, where k represents the number of means and n_2 is the residual mean square degrees of freedom in the factor under study. Two means are declared significant if

$$| \bar{x}_i - \bar{x}_j | > q_k \frac{S}{\sqrt{n}} \qquad (7)$$

where q_k is selected from the table, at the given α-level, for k means and n_2 degrees of freedom for the residual. Not only can pair-wise mean comparisons be made by this method, but also one can compare the average of one group of means with the average of another group of means. Note that the sample sizes must be equal for this method.

To illustrate this procedure, we shall use some data obtained in a market research (multiple packaging) experiment. The variable is some measure of sales. It was of interest here (in addition to studying treatment differences) to detect significant differences among the eight stores studied in the analysis. The residual mean square was found to be 6.86, and was based on 14 degrees of freedom. The store main effect yielded a computed F of 9.92. This was significant at better than the 0.05 level.

Since each store mean was based on $n = 12$ observations, the standard error of a single mean, from formula (6), is seen to be

$$S_{\bar{x}} = \sqrt{\frac{6.86}{12}} = 0.756$$

The value of q_k (for $k = 8$ and $n_2 = 14$) is obtained in Table VI and is 4.99. For a pair of means to be declared pair-wise significant, it is necessary that

$$| \bar{x}_i - \bar{x}_j | > 4.99 \times 0.756 = 3.77$$

Table VII—Upper 1 Percent Points of the Studentized Range, q

n_2/k	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	90.0	135	164	186	202	216	227	237	246	253	260	266	272	277	282	286	290	294	298
2	14.0	19.0	22.3	24.7	26.6	28.2	29.5	30.7	31.7	32.6	33.4	34.1	34.8	35.4	36.0	36.5	37.0	37.5	37.9
3	8.26	10.6	12.2	13.3	14.2	15.0	15.6	16.2	16.7	17.1	17.5	17.9	18.2	18.5	18.8	19.1	19.3	19.5	19.8
4	6.51	8.12	9.17	9.96	10.6	11.1	11.5	11.9	12.3	12.6	12.8	13.1	13.3	13.5	13.7	13.9	14.1	14.2	14.4
5	5.70	6.97	7.80	8.42	8.91	9.32	9.67	9.97	10.24	10.48	10.70	10.89	11.08	11.24	11.40	11.55	11.68	11.81	11.93
6	5.24	6.33	7.03	7.56	7.97	8.32	8.61	8.87	9.10	9.30	9.49	9.65	9.81	9.95	10.08	10.21	10.32	10.43	10.54
7	4.95	5.92	6.54	7.01	7.37	7.68	7.94	8.17	8.37	8.55	8.71	8.86	9.00	9.12	9.24	9.35	9.46	9.55	9.65
8	4.74	5.63	6.20	6.63	6.96	7.24	7.47	7.68	7.87	8.03	8.18	8.31	8.44	8.55	8.66	8.76	8.85	8.94	9.03
9	4.60	5.43	5.96	6.35	6.66	6.91	7.13	7.32	7.49	7.65	7.78	7.91	8.03	8.13	8.23	8.32	8.41	8.49	8.57
10	4.48	5.27	5.77	6.14	6.43	6.67	6.87	7.05	7.21	7.36	7.48	7.60	7.71	7.81	7.91	7.99	8.07	8.15	8.22
11	4.39	5.14	5.62	5.97	6.25	6.48	6.67	6.84	6.99	7.13	7.25	7.36	7.46	7.56	7.65	7.73	7.81	7.88	7.95
12	4.32	5.04	5.50	5.84	6.10	6.32	6.51	6.67	6.81	6.94	7.06	7.17	7.26	7.36	7.44	7.52	7.59	7.66	7.73
13	4.26	4.96	5.40	5.73	5.98	6.19	6.37	6.53	6.67	6.79	6.90	7.01	7.10	7.19	7.27	7.34	7.42	7.48	7.55
14	4.21	4.89	5.32	5.63	5.88	6.08	6.26	6.41	6.54	6.66	6.77	6.87	6.96	7.05	7.12	7.20	7.27	7.33	7.39
15	4.17	4.83	5.25	5.56	5.80	5.99	6.16	6.31	6.44	6.55	6.66	6.76	6.84	6.93	7.00	7.07	7.14	7.20	7.26
16	4.13	4.78	5.19	5.49	5.72	5.92	6.08	6.22	6.35	6.46	6.56	6.66	6.74	6.82	6.90	6.97	7.03	7.09	7.15
17	4.10	4.74	5.14	5.43	5.66	5.85	6.01	6.15	6.27	6.38	6.48	6.57	6.66	6.73	6.80	6.87	6.94	7.00	7.05
18	4.07	4.70	5.09	5.38	5.60	5.79	5.94	6.08	6.20	6.31	6.41	6.50	6.58	6.65	6.72	6.79	6.85	6.91	6.96
19	4.05	4.67	5.05	5.33	5.55	5.73	5.89	6.02	6.14	6.25	6.34	6.43	0.51	6.58	6.65	6.72	6.78	6.84	6.89
20	4.02	4.64	5.02	5.29	5.51	5.69	5.84	5.97	6.09	6.19	6.29	6.37	6.45	6.52	6.59	6.65	6.71	6.76	6.82
24	3.96	4.54	4.91	5.17	5.37	5.54	5.69	5.81	5.92	6.02	6.11	6.19	6.26	6.33	6.39	6.45	6.51	6.56	6.61
30	3.89	4.45	4.80	5.05	5.24	5.40	5.54	5.65	5.76	5.85	5.93	6.01	6.08	6.14	6.20	6.26	6.31	6.36	6.41
40	3.82	4.37	4.70	4.93	5.11	5.27	5.39	5.50	5.60	5.69	5.77	5.84	5.90	5.96	6.02	6.07	6.12	6.17	6.21
60	3.76	4.28	4.60	4.82	4.99	5.13	5.25	5.36	5.45	5.53	5.60	5.67	5.73	5.79	5.84	5.89	5.93	5.98	6.02
120	3.70	4.20	4.50	4.71	4.87	5.01	5.12	5.21	5.30	5.38	5.44	5.51	5.56	5.61	5.66	5.71	5.75	5.79	5.83
∞	3.64	4.12	4.40	4.60	4.76	4.88	4.99	5.08	5.16	5.23	5.29	5.35	5.40	5.45	5.49	5.54	5.57	5.61	5.65

k is the number of quantities (e.g., means) whose range is involved
n_2 is the degrees of freedom in the error estimate

Table VIII—Significant Store Differences

Mean	9.99	9.56	9.52	9.15	7.86	6.15	5.05	3.68
Store	A	H	C	B	E	F	D	G

Table VIII gives the eight store means ranked. Further, any two means which are significantly different are not underlined by the same line.

Tukey's procedure also makes it possible to compare groups of means. For example, Stores A, B, C, and H could be tested against D and F, if these appeared of practical importance in such a problem. In this case,

$$(9.99 + 9.56 + 9.52 + 9.15)\tfrac{1}{4} - (6.15 + 5.05)\tfrac{1}{2} = 9.56 - 5.60 = 3.96$$

Since $3.96 > 3.77$, we can conclude that these two groups, on the average, are significantly different from each other. It is important to emphasize here that not all such contrasts are meaningful in an applied sense. One must keep the objectives of the study clearly in mind.

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List of Short Courses in Quality Control

Usual Time Course is Held	Type of Course	Where Held	Course Director
February	Basic	University of Illinois, Urbana, Ill.	J. A. Henry
May	Basic (Textile)	North Carolina State College, Raleigh, N. C.	D. B. Stansel
June	Basic	Marquette University, Milwaukee, Wis.	Gayle W. McElrath
June	Advanced	Purdue University, Lafayette, Ind.	I. W. Burr
June	Basic (Graphic Arts)	Rochester Institute of Technology, Rochester, N. Y.	Harold Kentner
June	Basic (Chem. Ind.)	Rochester Institute of Technology, Rochester, N. Y.	R. D. Pease
June	Advanced (Chem. Ind.)	Rochester Institute of Technology, Rochester, N. Y.	R. D. Pease
July	Op. Research	University of Michigan, Ann Arbor, Mich.	Oscar Wesler
July	Basic	TAPPI Statistics Conference	M. S. Renner
July	Advanced	TAPPI Statistics Conference	M. S. Renner
July	Advanced	University of Oklahoma, Norman, Okla.	R. L. Huntington
August	Basic (Research)	North Carolina State College, Raleigh, N. C.	.....
August	Advanced (Research)	North Carolina State College, Raleigh, N. C.	.....
August 15-25	Basic	University of Michigan, Ann Arbor, Mich.	C. C. Craig
August 1-19	Basic	U.C.L.A., Los Angeles, Calif.	Edward Coleman
August 1-19	Advanced	U.C.L.A., Los Angeles, Calif.	Edward Coleman
Aug.-Sept.	Basic	University of Connecticut, Storrs, Conn.	R. M. Story
September	Basic	University of Mississippi, Oxford, Miss.	Gayle W. McElrath
October	Basic	State University of Iowa, Iowa City, Iowa	L. A. Knowler

A Consolidated Decentralized

Reliability and Quality Control Program

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THE ever increasing demand for more reliable military and industrial equipment has stimulated many thought provoking articles and statements concerning the most effective organization for quality and reliability, whether the quality or engineering organization should be responsible for reliability, or, whether the reliability function should be independent of both engineering and quality control. While there is no optimum organizational structure that would effectively serve all of the many different types of industry and products, there are some basic concepts and philosophies which the writer feels should be common to most types of product organizations.

Two basic questions regarding quality and reliability about which there appears to be a good deal of friendly disagreement not only between the quality control and engineering professional societies, but within the ranks of the individual societies as well are:

> Is there a fundamental difference between quality and reliability?, and,
>
> What activity within a company shall have the responsibility for reliability?

AN answer to the first question merely requires agreement on definitions which in itself is not an easy task. There are probably as many definitions of quality as there are types of industry and Mr. Webster further confounds the issue with a multitude of choices. To the general public, quality generally connotes superiority, however within industry it should normally be associated with conformances to specified attributes or characteristics. Although attributes of a given product may frequently be superior to a similar product, as long as the "similar product" meets the *specified characteristics* it would still be classed as a quality product.

Since all industrial firms are presumably in existence for the purpose of making money for the owners, a definition which has always appealed to the writer is "A quality product is one which satisfies the customer and makes an equitable profit for the company." A "reliable product" can be defined similarly. If it meets the quality and reliability requirements for which it was designed it is a "QUAREL Product".

A prime responsibility of a quality organization must always be one of assurance to management and to the customer that outgoing product conforms to specifications. Whether these specifications are optimum operation conditions under warranty or guaranty, severe environmental exposure with time, or, operating or shelf life degradation, they remain outgoing quality specifications. The only difference between product operating specifications of the past and "reliability specifications" of today is that specific failure rates, mean time to failure, etc., are now called out rather than more generalized performance with time requirements. The fact remains however that a reliability specification is still an outgoing product specification which requires assurance by the quality organization, just as any other specified characteristic.

THE second question should more properly read "activities" rather than "activity" and has an obvious answer to the writer possibly only because of his long standing philosophy that true quality and reliability can be achieved only through a team effort of engineering, manufacturing and quality assurance.

The organizational structure of the quality and reliability function within different companies will vary due to the type of operation and product—low volume complex electro/mechanical systems, precision optics, industrial instruments, high-volume continuous-process components, etc. Nevertheless the basic philosophy should be that reliability and quality are team functions of engineering, manufacturing and quality assurance and should be common to all with specific responsibilities assigned to each activity.

It is abundantly clear that quality and reliability must be designed into a product hence it is equally apparent that this responsibility belongs to the design engineer. This should include thorough testing and evaluation of all materials used in the product or in the manufacture of the product, and a final reliability evaluation of pre-production models. The actual pre-production testing and evaluation may be done either by quality assurance or engineering, however the responsibility for seeing that it is accomplished should be that of the design engineer.

The manufacturing organization must also have very definite

ASQC LCS Code 810:10;60;70:438

and well defined responsibilities for high quality manufacture and conformance to design and quality specifications. This should include checks and tests integrated into the production cycle to assure maximum defect prevention and reliability.

The third member and anchor man of the team must be the quality organization which has the prime responsibility of evaluation, assurance, and quality and reliability improvement through effective control and improvement of incoming materials and manufacturing processes.

Just as no one type of quality and reliability organization is best suited for all types of industry or even for all product divisions or subsidiaries within a company, so too can an originally effective program become obsolete by expanded product lines, company growth and increased reliability and quality requirements. Quality management must therefore be constantly on the alert to provide top management and the customer with the most effective and economical quality and reliability program possible.

New products at Texas Instruments will normally pass through a three-stage development. From our Research Division which serves all product divisions comes the original idea, basic research, long range design and laboratory models.

The second stage is operation, reliability, and production feasibility development accomplished by the engineering development department of the cognizant Product Division. Following the feasibility assessment, which includes development of the critical manufacturing processes, pilot production and complete operational, environmental and life evaluation, the product is turned over to a specific product or project engineering activity.

This engineering group is then responsible for: the development of detail manufacturing specifications, processes, and equipment; product refinement to accommodate the specific type of production; final evaluation of the technical capability; and, sustaining engineering and technological improvement throughout the production life of the product. Final quality and reliability evaluation is accomplished by quality assurance; however, the responsibility for obtaining the evaluation and management approval thereof prior to regular production, rests with the product engineering group.

The Semiconductor-Components Division of Texas Instruments is a completely autonomous product division manufacturing more than 150 types of semiconductor devices, precision resistors and solid tantalum capacitors. Formerly a centralized engineering-manufacturing type organization, the division is now decentralized into six principal product departments responsible for the production engineering and manufacture of specific product lines. In order to keep pace with growth and changing requirements, the quality and reliability organizations have just completed a three-stage reorganizational consolidation and decentralization development which we feel provides maximum effectiveness and efficiency to our quality and reliability program.

IN ORDER to strengthen activities which have somewhat common objectives, the quality control department, qualification and evaluation branch of central engineering, and the operations research branch of industrial engineering, were merged in January 1958 as separate branches of a common quality assurance department with the former Q and E activity becoming the reliability assurance branch. After a six-month comprehensive formal training program of all personnel in both basic and advanced quality control and reliability methods and techniques, the quality control and reliability branches were reorganized along product lines with each product section head responsible to separate quality control and reliability assurance managers.

In order to meet more effectively increasing quality and reliability requirements, the reliability assurance and quality control functions have been more recently consolidated into decentralized productized quality assurance branches responsible for both quality and reliability assurance for specific product lines. These QA branch managers along with the operations research branch manager report to the quality assurance department manager. The QA manager reports to the vice-president of the division who in turn is responsible directly to the president of the corporation.

Each QA branch is composed of a quality control, reliability evaluation, and engineering section. Quality control is responsible for the evaluation and quality assurance of all incoming materials and chemicals, process controls, final test and acceptance of the end product, and vendor and customer quality service. The reliability section performs environmental and life test evaluation of pre-production samples of product for product engineering and sustaining weekly reliability tests throughout the production life of the product. The quality assurance engineering section provides staff assistance to both the quality control and reliability evaluation sections in conducting process and product capability studies and for a continuing program to improve the quality and reliability of all products under the cognizance of the specific quality assurance branch.

In summary we at TI feel: that quality and reliability are too closely allied to be divorced; that design engineering, manufacturing and quality assurance have joint quality and reliability responsibilities; and, that true quality and reliability can be achieved only through a team effort of the engineering, manufacturing and quality organizations.

In conclusion the writer would like to re-emphasize that while we feel we have the most effective quality-reliability organization possible for our particular operation and requirements, it will not necessarily prove best for other companies and conditions, nor, will it necessarily fit our own needs a year or two from now. Although considered best at this time, changing conditions may require additional changes and refinements in our organization and if these are in the interests of better quality and reliability of TI products they will, I am sure, be made.

The Role of Quality Assurance In Product Reliability

Part II

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Evaluation of Field Results

THE advantages of systematic collection, analysis and evaluation of the results of product performance in the field appear to be so obvious that one is surprised at the frequency with which formalized procedures for this purpose were so long lacking. The only true meaning and measure of product reliability lies in its performance in the field — in the hands of the ultimate user — where it is free of the guiding apron strings of an indulgent wet-nurse. It is here, and here only, that all pertinent performance factors — human foibles included — react together. No test, no simulation can equivalently substitute for actual service in the hands of the user. This fact is only one of several which indicate the uncertainty attendant upon "before-the-fact" reliability prediction.

Receipt of information in the form of complaints requires no voluntary action upon the part of the supplier. As has been pointed out, it was complaints by the military concerning unreliability which sparked such a widespread interest in this area. Within the Bell System, where the Operating Telephone Company is guaranteed satisfactory product performance over its entire reasonable life, the complaint activity furnishes much more comprehensive performance information than is normally to be expected from this source. Many of the causes of unreliability—especially those like stress-cracking[7] which require time for their development—have been disclosed by complaints. But complaints alone are not a sufficient barometer of product performance. Isolated instances of trouble, which may not at the time be considered cause for complaint, may by careful analysis disclose conditions which are potentially serious. Hence, specific arrangements are needed to acquire, on a continuing basis, performance results in addition to those which may be furnished through complaint channels. In any event, whatever its source, the full value of such field information should be utilized. This means that its significance be fully evaluated and that, if corrective or protective action is indicated, suitable steps to this end be taken. It is the demonstrated importance of this often neglected phase of quality assurance — and the fact that such a large preponderance of the really important irregularities thus disclosed relate to design — which led me to select it for specific comment. It is not a "Johnny come lately" phase. When Bell Telephone Laboratories was incorporated in 1925, engineering complaints* were recognized to have such an important bearing on design, particularly reliability, progress that their handling was purposely allocated as a Laboratories — and specifically a quality-assurance function. Here we have a clearly documented illustration of the design aspect of the quality assurance program.

The Quality Survey

If the second antecedent of reliability — a complete statement of specification requirements — existed, the inspection phase of quality assurance might in itself suffice. The task might involve a difficult, highly sophisticated procedure; but inasmuch as it would represent only the process of determining product compliance with stated requirements, it would be an inspection process. Unfortunately, and especially with the more complex designs, the specification requirements by themselves are almost always inadequate. They may omit necessary requirements (and perhaps this is their most frequent, critical shortcoming), they may assume that which

*Engineering Complaints are those relating to technical features of product quality. They cover instances of failure to meet specified requirements, short life, unsatisfactory service, etc., as contrasted with commercially adjustable irregularities such as shortages. As a technically competent organization — independent of responsibility for design, production, or use — Quality Assurance's findings as to responsibility for the complaint condition are final.

Editorial Note

This paper was presented by invitation on the program of the Symposium on Reliability of Service Equipment sponsored by the British Ministry of Supply in London, England, March 22-24, 1960. In releasing this paper for publication in IQC, Mr. Coppock of the Ministry of Supply makes these interesting comments: "We do not necessarily support a separate organization for quality assurance, such as Mr. Paterson describes, though we are interested in its possibilities in many directions. There will in fact be quite a debate on this very point during the Symposium."

The "Comments on the Paper" represent a supplement to it which Mr. Paterson was invited to prepare and present, the paper itself having been distributed for study prior to the actual Symposium dates.

ASQC LCS Codes 300;800:60;70:400

Part I was published in the July issue, *Industrial Quality Control.*

cannot be left to assumption, or they may be ambiguous. It was in recognition of these possibilities that quality assurance, upon its inception in Bell Telephone Laboratories, was assigned the responsibility for critically reviewing the design requirements as part of an activity known as the Quality Survey.

The Quality Survey includes a comprehensive, critical review of all factors which may have a bearing on product quality, from the design concept through production and use. Its purpose is to disclose any circumstance which may affect quality adversely, and to initiate steps to eliminate any such circumstance. Thus it reviews not only the quality related activities of others, but also the propriety and adequacy of its own activities. Of all the several activities of quality assurance, it is, because of its wide scope, the one which may be expected to contribute most to product reliability. The survey is carried on by a survey committee comprising three members: (1) a quality engineer who is a specialist with respect to the particular type of product under survey(a member of the Laboratories quality assurance organization who acts as chairman of the committee); (2) a member of the Western Electric's (manufacturer's) quality assurance organization which functions as the Bell Laboratories' agent in securing the independent inspection results specified by the Laboratories; and (3) a member of the Western Electric shop organization. (In the case of surveys covering products obtained from non-Bell System sources, the third committee member is a representative of the supplier). A separate committee handles each survey, of which there are about 50 each year covering a wide variety of apparatus, equipments, and systems. The Laboratories member is a specialist on a particular type of product or system. As such, he is familiar with the design, manufacture, and use of the product or system and with its field history. Each Committee member has his particular responsibility and makes his individual contribution to the survey. An outline of what the Bell Laboratories' member does will suffice to describe the survey process, since he is a quality specialist and his duties are most comprehensive.

(1) A Detailed Examination of the Design Requirements

As has been indicated, the potential reliability of a product is determined by the effectiveness with which the design concept is expressed in terms of the specification requirements. In the ultimate this means that each material, each component, and each manufacturing process must be so completely and clearly specified that product manufactured in full compliance with these requirements will represent the physical embodiment of the designer's concept and will thus provide the reliability intended. The preparation of such a comprehensive definition represents a challenge to the designer which is almost impossible for him to accomplish.

It is not sufficient, for example, that he specify a particular component by code or catalogue number, unless he is fully assured that by so doing he limits the use of all such components to those which have all their characteristics (including life) sufficiently close to those intended as to insure the desired integrity of the completed product. It is not sufficient that he specify that a connection be soldered. He must specify in detail the wire wrap, the flux, the solder, and the criteria which characterize a good soldered connection. If wiring requires a particular spatial configuration to avoid electrical crosstalk, he must specify the configuration, and the means for insuring its position stability if service use may otherwise cause shifting. If the associated test equipment is special, if its inherent errors of measurement are significant, if its stability is poor, or if its use involves special techniques, he must include appropriate requirements in his specifications. These are a few typical examples of the many for which inadequate specification restrictions have resulted in unreliable product.

Never are the specification requirements complete in the very strict sense in which I have used the term. The survey engineer must judge the reliability potentialities of any incompleteness which his critical review of the design requirements discloses. His judgment is tempered by his background knowledge and experience and by pertinent circumstances. In the case of the TASI transistor mentioned earlier, and specified by code number only, he is aware of all of the controls which have been and continue to be applied to insure a homogeneous output in keeping with the one percent failure prediction. In fact, it is his responsibility, in the course of his other quality assurance activities, to insure that a corresponding quality is specified and maintained. If the product were to be produced under circumstances where a corresponding level of quality could not be taken for granted, he would be expected to see that the requirements for the transistors were suitably amplified.*

Despite precautions which are taken to avoid them, it is surprising how frequently errors, incompatibilities, and ambiguities may sneak into design specifications. They result not from incompetence but from the sheer complexity of the design problem, from the fact that so many design specialities and the work of so many design specialists must be correlated, and from the pressure generated by the time urgency which is so characteristic of today's development tempo. The survey engineer searches for such irregularities.

(2) Examination of Product Sample

If the design is already in regular product[illegible] the time of the survey (as it usually is, since [illegible] primarily concerned with design shortcomings [illegible]ich are not readily disclosed and corrected in the initial stages of production), then a random sample of completed product is selected for detailed examination. The purpose of this examination — conducted jointly by the design and survey engineers — is to determine visually how closely the actual product reflects the designer's intent, especially with respect to those features for which requirements are often specified in qualitative rather than quantitative terms, and which do not lend themselves to verification by physical measurement. It is during this examination that the designer himself frequently notes conditions which are unintended, or the absence of features which were intended, but perhaps not provided for in the design specifications.

(3) Comparison of the Design and Manufacturing Information

In many cases, it is the practice to replace, in whole or in part, the design requirements by so-called manufacturing specifications and drawings. This constitutes a process of translation of one form of information into another, better suited to manufacturing purposes. Tooling, processing, manufacturing sequence, gaging information, and the like, may be added. It is the information used in the actual manufacturing operation which determines the quality of the product. If the information

*In this connection, with its close and long-time cooperative effort among the development, production and using agencies, the Bell System set-up has inherent advantages quality-wise and reliability-wise. It has developed over the years many internal quality standards, especially those relating to "workmanship" which, if not actually expressly stipulated, are nevertheless so firmly embedded in precedent as to be recognized and accepted automatically by all concerned. Thus many features of design intent which under an arms-length relationship between designer, producer, and customer must be specifically covered by statement, are, in the Bell System, construed as implicit. This circumstance lightens the burdens of both the designer and the quality assurance engineer considerably.

used represents a translation, it is essential that this translation have been made without errors or omissions, and that any added information, such as inspection and process control layouts, be completely compatible with the original. The survey engineer reviews the manufacturing information to insure that this need has been met.

(4) Review of Inspection Procedures

Inspection was earlier cited as an aid to reliability. Its contributions are in direct relation, however, to the thoroughness with which the inspection procedures are specified. With a detailed knowledge of the design requirements freshly in mind, the survey engineer reviews the inspection specifications in accordance with which he obtains his inspection results. Do they, in fact, he asks himself, provide that adequate information to portray the true quality of the product will be forthcoming, insofar as it is possible for inspection results to supply this information? This question applies not only to the complete device or system under survey but also to the individual materials, components, and processes which go together to make the device or system. Are the size and manner of selection of the inspection sample proper? Are the acceptance criteria in keeping with the quality standards which have been established? To answer these questions, he must know the nature of, and procedures covering, the shop inspection which precedes the quality assurance inspection for which he prepares his specifications.

(5) Review of Inspection Results

The inspection results constitute the most direct and comprehensive individual picture of product quality. They represent the information upon which the decision is made as to the product's acceptability. The survey engineer reviews them to determine whether they are as called for in the inspection specifications, whether they are in fact adequate for his needs, and whether they indicate the product to be in keeping with the quality intended. He looks for chronological trends in the results; he looks for non-conformances and weighs their frequency, and their nature and their significance; and he looks, in particular, to see that the results as shown by shop inspection are compatible with those shown by the quality assurance inspection.

(6) Review of the Results of Field Performance

Since the acid test of quality is reflected in actual performance in the field, the survey engineer reviews the performance results critically. From them he may detect shortcomings in design, production, or quality assurance itself. Field results provide a sure road, often a slow road, but in the case of slowly manifested reliability failures, sometimes the only road to learning. Many of such ailments as silver migration [8] depended upon long service for their disclosure as an incentive to laboratories research for their avoidance. They are directly related to reliability as we have previously noted.

(7) Examination of Actual Production Procedures

Armed with the information furnished by all that has preceded, the nature and portent of which are included in preliminary reports*, the committee visits the producing facility and makes a thorough, detailed study of the manufacturing operations. This study includes a critical review of each of the processes relating to materials, parts, assembly, and both shop and quality assurance inspection and testing. It includes a careful evaluation of all of the gaging, testing, and inspection facilities with respect to their adequacy, accuracy and maintenance. It ascertains whether these facilities are being used correctly by the operators. Both the actual quality of the product as well as its undistorted reflection in terms of inspection results depend upon the suitability of the facilities themselves and upon their correct use in the hands of the operators. The committee searches for any factors in the entire production process which might affect quality adversely. It looks for any gaps in the safeguards to quality.

(8) The Quality Survey Report

At the completion of the survey, the committee prepares a report which describes the quality status of the product, cites any significant quality shortcomings disclosed, and recommends, to the organization responsible, action necessary to remove these shortcomings. These action items may relate to unsatisfactory features of the design; inadequacies of the manufacturing or inspection processes; improper, incorrectly used, or insufficiently maintained testing and measuring facilities; incomplete or incorrect inspection records; oversight, incompatibilities, or improprieties in any phase of the quality assurance program itself; or any of the many other possible assignable causes which could lead to sub-standard quality. The responsible organization must take corrective action which is satisfactory to each of the members of the survey committee before the item is closed; and is followed up diligently until such action has been taken.

From the foregoing description*, it will be apparent that the Quality Survey represents a thorough-going, overall review designed to disclose and rectify any circumstances by which quality might suffer. It analyzes the whole product history — design, production, and use. Each of its steps is designed to profit from the "feed-back" effect of each of the others.

As might be expected, special emphasis is given to those features of quality which are most important from the standpoint of the nature and use of the product. Thus if we are dealing with a product where reliability is an especially critical component of quality, and where features of the design, production, or use are such as to make reliability potentially highly variable, those factors relating to reliability are stressed particularly. Safety-affecting attributes (in many cases these represent a special aspect of reliability) are, in both industrial and military applications, of outstanding importance. With such items as ladders, safety-straps, and high voltage equipment in the communications business, and with such features as fail-safe devices in military missiles, safety considerations are paramount, and the quality survey pays them special attention.

While the study is inaugurated and prosecuted under the official aegis of an independent Survey Committee, the combined talents and knowledge of the designer, manufacturer, and using customer are freely solicited and provided to the end that no stone be left unturned in the search for quality safeguards. By contrast with the few minutes involved in its description, surveys of the more complicated systems involve two or three month's preparational effort on the part of the Bell Laboratories' quality assurance engineer alone; and his preliminary report for discussion at the formal conference may include 20 to 30 typewritten pages listing errors, omissions, and noteworthy findings and comments. As a commentary on the extreme importance of the design phase of reliability, it is of interest to note in some 1500 quality surveys covering a wide variety of materials, components, apparatus, and systems, major irregularities in design have been found to outnumber those in production in the order of two to one.

As might be expected, in addition to their worth as quality safeguards, these surveys have a tremendously important educational value — to the survey engineers themselves, to the designer, and to the

*Preliminary reports are prepared by each Committee member.

*The Flow Chart shown in the Appendix hereto may help the reader to visualize the Quality Survey process.

producer. Attention to, and removal of, a quality deficiency thus disclosed today may be expected to cause avoidance of a similar deficiency in product designed and produced tomorrow. The cumulative value of these surveys over a period of years has been such that currently many of the less complex products get an essentially clean bill of health in the survey report — and everybody rejoices. The advanced listing of the products scheduled for survey during the coming year (and the listing and schedule can be altered to fit circumstances) has a salutary housecleaning effect.

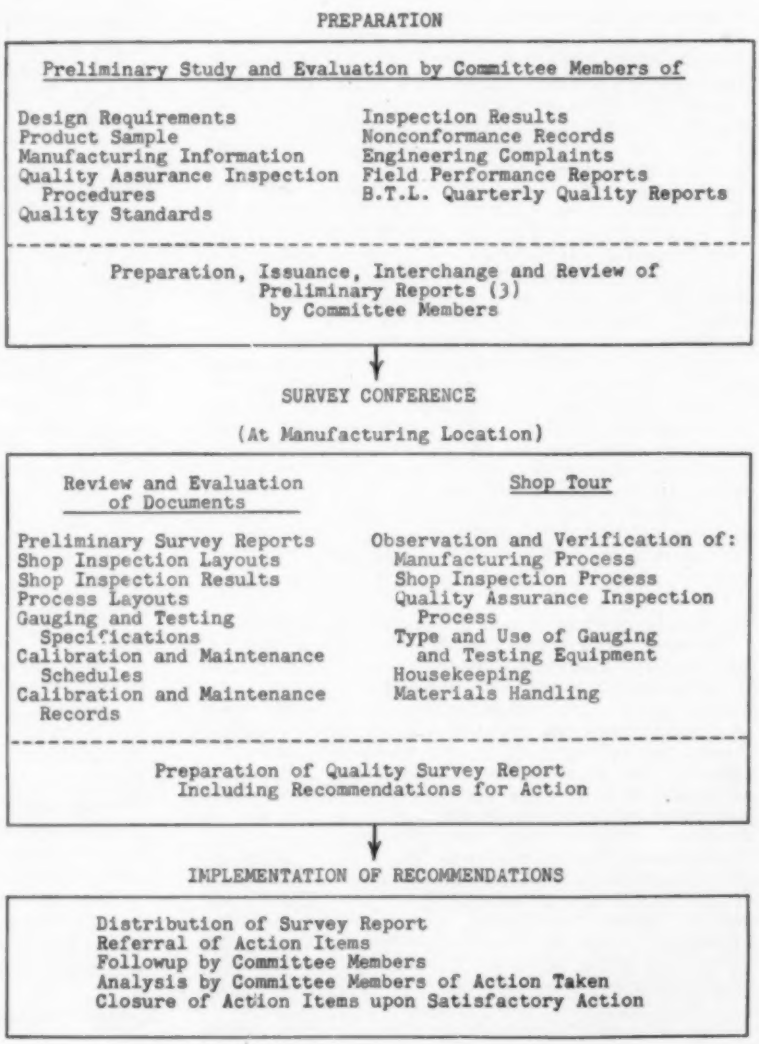
Conclusion

In the foregoing text I have tried to indicate several ways in which it appears to me that quality assurance can be particularly helpful in our joint effort to improve Reliability. Although, so far as I am aware, its use in the military area, in the broad sense described in this paper, has been limited, it has in several instances been very effective.[9] A large part of its success in these cases is attributable to the fact that those in the military, who were responsible for its introduction, appreciated its potential effectiveness, gave it their hearty cooperation, and assigned to it the authority and operational "Lebensraum" which it must have.

If it happens that the practice of what may be called quality assurance by other industries is not concerned with reliability, this is only because it does not encompass the full intent of the program with which the term "quality assurance" was first inaugurated. The Bell System comprises a team of specialized performers — research and development (Bell Telephone Laboratories), production (Western Electric Co.), and operation (The Bell Telephone Operating Companies) under the coordinating guidance of the American Telephone and Telegraph Company. Each of its members has long been aware of the need for his own best efforts to secure reliability. Few industries perform a function in which the customer's dependence upon systems reliability is more vital, or his expectations with respect to it better fulfilled. Reliability as a part of overall quality was a thoroughly inbred concept and a conscientious aim long before such a tool as quality assurance had been devised as a helper. It is a sorry admission on the part of any industry if it must look upon today's spot-lighted attention to reliability as an indication for the need of insemination rather than of nourishment and education.

Let me disclaim strenuously any intention to make the quality assurance program or its practicing engineers appear to be omnipotent. Reliability follows only after each of the many competent specialists involved in the creative sequence has contributed his indispensible share. The quality assurance engineer brings to bear a somewhat different point of view which arises from his particular type of training and his broad quality experience. He diagnoses and applies a counter-irritant to incite the flow of curative ideas from the other specialists. Skepticism forms a necessary part of his diagnostic training and criticism a necessary ingredient of his counter-irritant. His purpose is constructive, and he tries to conduct his ministrations in a manner conducive to organizational equanimity. He is under no illusion that the critic outranks the creative author in importance.

In attempting to explain the frame of reference from which Quality Assurance approaches the problem, I raise a serious eyebrow at the present fallibilities in reliability prediction. In so doing, I am not questioning in the least the great value of the reliability programs which are designed to search out and eliminate the underlying causes of unreliability,



and to provide more and better knowledge about materials, components, circuit applications, and assemblies which will foster reliable designs. It is to the loose use of purportedly sound reliability forecasts that I direct my attention, especially as these apply to new, complex systems. My reaction is prompted by experience with a broad range of communication devices and systems representing a large sample and a long life in service. We, in Bell Telephone Laboratories, were among the first and continue to be great respectors and large users of statistical techniques for research and industrial purposes. We try to use them for all — but I hope not for more than — they are worth. We are always influenced by that non-measurable psychological motivator known as "the degree of belief" for which Dr. Shewhart[3] suggested the probability symbol P'_B. It is the "degree of belief" which leads to decisions; and quality assurance is largely a decision-making process. Statistical techniques are tools — very valuable tools — and one of their progeny, reliability prediction, is also, and should be used as, a tool. It is my feeling that, until we have become more skilled and knowledgeable in its use, we would be well advised not to include its results as an explicit part of the quality which the customer is led to expect with confidence in new, untried, complex products.

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The Role of Quality Assurance in Product Reliability

Comments on Paper

In America, if not in Britain, there is an oft expressed implication that, after all these years, industry must be bludgeoned into recognizing the importance of reliability, (if not even the very existence of such a concept). I do not blame the military for their importunities. But I do think that it is important to make clear the fact that, speaking generally, the military has been victimized by ignorance rather than by disinterest. The will to do has often been thwarted by the lack of know-how. When industry operates in an area with which it is familiar, reliability usually follows as a normal quality attribute.

At the time I entered the Bell System, some 40 years ago, reliability — as used in its strict present day connotation — had not been heard of. When an engineer designed a relay, he specified erosion-free contact material, minimum contact pressure, contact wiping action, contact protection, fatigue-resistant contact springs, stable spring pile-ups, current operating margins, and the hundreds of other requisites for relay reliability. But he would have characterized his design requirements merely as those necessary to a high quality relay suitable for telephone service. The practice of making devices and systems, so as to provide dependable, long-life, trouble-free service was a religion with us long before "reliability" had become a catch-word. Without this catch-word, we would still have proceeded, and proceeded successfully I am sure, to develop and build a system suitable for nation-wide dialing — a system in which completely mechanized interconnection between some 60 million subscribers is possible — a system whose reliability aspects are really fantastic.

To what have our communication systems owed their reliability? To what do your historically famous edifices owe their style and durability? Not primarily to good production facilities, techniques, or competence, although these were, of course, necessary. Rather it is to the designer who knew so well what to use and how to use it. Herein lies the secret of the creation of durability, of reliability, and of all the other qualities with which industry is concerned. As the product becomes more complex, as its function becomes technically more arduous, as its parts become more novel, as their interactions become more involved, the more elusive become this secret. And the more, exponentially more, difficult becomes the passing of this secret to others — the producers — who must build it into a corpus.

This is the crux of our military reliability problem today. We are dealing with so many technological strangers; we lack experience. One could not be so long exposed, as I have been, to the Bell Laboratories' predilection for innovation and progress without becoming infected with the spirit of "naught venture — naught have." But this stalwart "venture" is not the best bed fellow for reliability; in witness whereof we temporarily anesthetized him and selected experience while we were designing and manufacturing the transatlantic cable. I am sure that our counterparts in your country did the same.

Now by stressing the importance of the design problem, and the value of experience in its solution,

I do not mean to imply that the producer has no responsibility with respect to reliability. He has, of course; but, in the sense that we are discussing the reliability problem, his responsibility is to execute instructions rather than to issue them — to do rather than to think*; and the degree to which he succeeds is subject to immediate measurement, whereas that of the designer is not.

This is what led me to select for discussion those less known phases of quality assurance which relate more particularly to the design aspects of reliability. Except by pure chance, a product will not have a greater reliability than the designer has engineered into it. He, himself, doesn't know *what* degree of reliability he has obtained until the stages of production and substantial usage have passed. He builds a model, perhaps several if he is so fortunately circumstanced; he subjects the model to tests, usually very limited tests in terms of actual service requirements; and, unless he is an extraordinary genius or is unusually blessed by good luck, he revises his design to correct its deficiencies. When he has repeated this performance until he arrives at a result with which he is satisfied, he takes the next difficult and critical step: he tries to define his design in terms of words, lines, and figures by which a second party, without the benefit of the designer's knowledge as to why, can build in quantity, under commercial conditions, duplicates of his prototype. If the design requirements are complete and the producer follows them to the letter, we end up with a product whose reliability is predicated largely upon the results obtained on a very small sample of a model subjected to limited tests. These critical limitations lead me to regard with apprehension any reliability prediction which assumes the guise of a solemn promise.

I do not wash the designer's linen in public to embarrass him, to belittle his ability, or to minimize the competence which he has demonstrated — so outstandingly of late. I have been a design engineer myself, and I have observed that what I have described is the way a designer — a good designer — operates. It is his way of life; it is, in fact, the way of progress as many years of industrial history have shown. This is why I bemoan the currently increasing tendency to promise high and allegedly precise figures of reliability for complex and untried military products. When such figures are merely in the form of window-dressing in advertisements, they amuse, and cause no harm in the hands of the astute. When, however, they appear in the form of a warranty, exacted by the customer from the supplier, they are dangerous; they encourage the customer to plan on the basis of a commitment which the supplier cannot possibly be sure he fulfills. They are anathema to the quality engineer who associates a large degree of realism with his assurance. To paraphrase a statistical saying: "Figures don't lie, but they may be misused to create a Lorelei for the unwary."

I write these words on the day following my Country's failure in its November attempt at a Moon Missile. No one can doubt that many of our best brains, much of our money, and all of our hopes were directed to its success. No one can doubt that its predicted reliability before launching was as high as our ingenuity knew how to make it. It failed!

Let me say in closing these supplementary comments that I hope my enthusiasm for the quality assurance activity has not led me to imply that it brings with it a magic formula or procedure by which a clear roadmap to reliability may be drafted. There is no such formula or procedure. During the past 15 or 20 years, all of us have been in the position of not quite solving the reliability problem on one product before we are confronted with a new, and often quite different, problem on another. We do not start from scratch each time, our lead is greater and greater; but we never seem to have enough time to finish the race. Strictly speaking, quality assurance is not even a runner in this contest between the designer's knowledge and time. It functions in part as a monitor, and in part as a coach who helps by injecting the knowledge which he gains from watching and monitoring many races. It isn't perfect, it isn't a panacea, but it has proved its worth as a helper. My experience with it has naturally been predominantly in the field of communication, but I have seen enough of its application in the area of military product to convince me that if used in the way, and by the type of people, I have described, it can be expected to help those whose responsibility for reliability is primary.

*Lest these words invoke the wrath of the producer, I hasten to emphasize that I am referring specifically to functional responsibilities. The producer often does, in fact, "think" in the area of design responsibility; and his resulting ideas and suggestions have played a most helpful part in increasing reliability. But his primary thoughts are directed to "how to do it" not "what to do", and it is in the "how" domain that he has demonstrated his acknowledged ingenuity.

EMPLOYEE COOPERATION

in meeting your Quality Objectives can be accelerated by

THE ELLIOTT HI-VISION PROGRAM

(See page 44)

SAN FRANCISCO CONVENTION A

SUCCESS

It was with some trepidation that the official family of ASQC approved the 14th Annual ASQC Convention for San Francisco approximately five years ago. Save for the perseverence of Dale Lobsinger, the convention may not have been in San Francisco. Indeed is was a courageous venture for it is the first time since St. Louis that an ASQC annual convention has been held west of the Mississippi.

An unofficial tally shows that this confidence was not misplaced since approximately 950 registered for the convention. This compares favorably with pre-convention estimates of 850.

Pre-Convention Reception

Monday, May 23rd, promptly at 6 p.m., delegates to the 14th Annual Convention and Exhibition started arriving in the Gold Ballroom of the famous Sheraton-Palace Hotel in San Francisco. Winding their way past several tables they "sampled" the many varieties of fine California wines. The traditional sour dough French bread and cheese were available to prevent flavor carry-over.

Invariably the guests were interrupted many times by the discovery of old friends who were engaged in the same wine sampling session.

To help set a background for the event, Walt Tollefson's four piece combo, dressed in old California costumes, played soft music which helped set a gay tone for the evening.

Before the evening closed around 9 o'clock, approximately 500 persons had found their way to this very delightful and unique reception. No doubt many of them will have a greater appreciation of the use of wines, and will have made many new friends and renewed old acquaintances. From here, many of the delegates proceeded to discover or rediscover the San Francisco night life.

Program

A program of excellent speakers from all over the country presented subjects of timely and vital interest and of importance to all American Society for Quality Control Members.

The entire program showed the care with which the speakers and their subjects had been selected. The talks were varied enough to meet the needs of the majority of those in attendance, and wide enough in scope to be pleasing to all. Each day was opened with a General Session conducted by an outstanding speaker. This was followed by from 18 to 27 sessions.

Each day the convention opened at 9 a.m. and featured six concurrent sessions. The various fields represented included chemicals, metals, administrative applications, reliability, foods, education and training, operations research experimental design, professionalism, an inspection workshop, and the armed services, plus several panel discussions on selected subjects.

The "Inspection Workshop", a new idea growing out of last year's Shirt-Sleeve Clinic, ran concurrently with the quality control program and proved a big addition. Polls taken at several of the Workshop sessions indicated its attendance as: one third, engineers; one third, quality control people; and one third inspectors. More than two hundred persons attended some of its sessions.

Plant tours were available to those interested. These tours seemed to suffer with competition of the sessions. As a result, the busses were sparsely filled.

Harter Hudson, general chairman, opened the convention Tuesday morning by welcoming the convention to San Francisco and reading a proclamation by the mayor of San Francisco, George C. Christopher, declaring the week of May 22, "Quality Control Week."

As expressed by President C. E. Fisher in his opening remarks, "The attendance at this Convention is truly remarkable, somewhat exceeding the expectations, if not the hopes, of some of us . . . Very fortunately we have had one of the finest Host Committees in our Convention history under the direction of Harter Hudson."

President Fisher introduced the keynote speaker, Rudolph F. Bannow, president of the National Association of Manufacturers, who delivered a most inspiring address. The title of his paper was "Let's Keep 'Made in America' the World's Quality Standard." The theme of his presentation was the U (you) in Quality — the importance of recognizing the individual worker or craftsman on the job, to make him feel a member of the team, and in so doing to help him gain self-esteem from this recognition of his role in continuing quality.

His theme, "U", the men in Quality Control, was repeated again and again by speaker after speaker. Mr. Bannow emphasized the necessity and importance of having men interested in working *with*, rather than *for* their companies, and the efforts which were being made to obtain such an attitude.

Likewise, Paul S. Olmstead, in accepting the Shewart Medal said in his talk, "Road to Understanding":

> If we are to reach such a goal, each of us must contribute to the maximum of his ability. This means that we must continue to extend our understanding of our various problems. We need more knowledge of statistical methods and the assumption on which they are based. We need to know more about the natural sciences and their relation to engineering. Above all we must not forget that *people* are important.

This same theme was also carried out in many papers presented at the convention — to mention a

few, "Higher Quality — Through People in Quality; Quality in People" . . . "The Inspector's Place in Quality Control" . . . "Training Inspectors and Apprentices" . . . "Fifty Thousand Partners" . . . "Videosonic Instructions Raise Quality Standards."

Past president Si Collier, when accepting the Edwards Medal said: "As the years have gone by I have learned that there are four major elements involved in production, namely: materials, machines, processes and men. I am going to talk about one of these elements, 'people', for I believe this is the most important element. I would say that unless we recognize this important element and make the necessary plans to obtain the utmost cooperation from everyone involved, the best results can rarely be obtained no matter how well we plan our programs."

The second day of the Convention was opened with a general session in the Gold Ballroom. J. Y. McClure, president-elect, presented to John J. Riordan of the Department of Defense a special citation of the Board of Directors of ASQC. This Award, in the form of a plaque, commended Mr. Riordan for his work in promoting and augmenting quality control in the Department and for his cooperative efforts in coordinating the quality control phases between the Department and Industry.

Following the presentation was an address by Rear Admiral Paul D. Stroop, Chief, Bureau of Naval Weapons, on "Reliability of Guided Missiles."

According to the Admiral, mass production no longer provides our nation with the military advantage it did in World War II, but rather the premium is on scientific achievement.

He called for industry participation in quality control among all the contractors and subcontractors who produce components.

Comparing the problems of materials in World War II with the present "cold war," the Navy spokesman noted that, given time and protection, American factories in the earlier crisis were able to produce "more than enough to meet the need."

But today, he explained, the premium is on scientific achievement.

Admiral Stroop said: ". . . As a nation, we see the degredation of what many have accepted as our greatest military asset, our productive capacity. Obviously our precepts based upon mass production must likewise yield to the exigencies of the time; quantity thinking must give way to quality thinking." "We may not have to produce so much, but we have to be smarter in doing so."

In this shift from large production to stress on research, the admiral continued, means are needed for evaluating the potential products, for weeding out unpromised systems long before they reach the expensive production stage.

"With our larger missiles," he declared, "a trial and error approach is beyond both our productive and financial capacities. We must learn how to incorporate quality and reliability in the design stage."

Admiral Stroop emphasized that quality control techniques used for mass production of civilian goods are inadequate. He said there is "abundant evidence" of too many products requiring repair.

He said that in day of "exploding technology" there must be accurate judging of quality, time required and cost from drawing board through production of component by component. "We must count on industry to meet quality requirements as efficiently as possible," Admiral Stropp said.

Exhibits

The Exhibits were well attended and for the most part were working exhibits with equipment, all of this lending added interest to all convention participants. The following companies had exhibits at the convention:

American Cystoscope Makers, Inc.
Continental Can Company
Convair — Division of General Dynamics Corporation
Coulter Industrial Sales Company
DoALL Company
Elliott Service Company
International Business Machines
Lockheed Aircraft
Lufkin Rule Company
Monode, Incorporated
Monroe Calculator Company
Owens-Illinois Glass Company
Pennoyer-Dodge Company
Quality Control Company
Rototest Laboratories, Inc.
Scherr-Tumico Company
Harry M. Smith & Associates
L. S. Starrett Company

The sessions were staggered to provide maximum opportunity for the conferees to attend sessions of special interest and to view the exhibits. Also, to provide maximum flexibility in visiting the exhibits and attending the technical sessions, no luncheons were served. This provided an opportunity for small groups to gather informally at restaurants of their choice to conduct business and renew acquaintances.

Social Evening

The Social Evening provided another opportunity for old quality control cronies, as well as new ones, to make and renew acquaintances in a Barbary Coast ("Gay Nineties") theme. In keeping with the theme of the convention "Quality Control — the Golden Gate to Higher Profits," golden nugget key chains were presented at the gate. Unfortunately, the gold theme was carried a little too far and a lone bandit robbed the bar of its weeks accumulation of gold dust. During the fracus that followed, Harter Hudson, prominent San Francisco gambler, was shot by the masked robber, suspected to be Gene Brown, notorious local gunman.

After the gunsmoke subsided, the visitors enjoyed the music of the national recording Red Garter Band. Molly and Kay, two well distributed entertainers from 56 Gold Street, a San Francisco bistro, added to the fun and merriment of the evening.

Ladies Program

One of the highlights of the convention was the ladies program, chairmanned by Alice Hudson and Lou Hile. (To our knowledge the registration of 120 ladies was the largest number in the history of ASQC national conventions.)

On Tuesday, the ladies took a short cab trip to Jackson Square, where they toured the Interior Decorator shops that comprise the Square. These shops are normally open only to the professional decorator and his clients. Here they saw elegant fabrics from all corners of the world, in countless profusion of texture, hue, and design; masterfully detailed furniture of every period and style; lamps, vases, and other furnishings of exquisite material and design.

The shops themselves are a unique blend of old and new: historic buildings along narrow alleys

of the Barbary Coast have been tastefully renovated to create a showroom atmosphere unduplicated anywhere in the world.

A cocktail at the Owl 'n Turtle Restaurant completed the tour.

Wednesday's tour began with a scenic bus trip of San Francisco, and across the Golden Gate Bridge to Sausalito, a quaint Bohemian village nestled on the shores of San Francisco Bay. Here the ladies enjoyed lunch at Ondine's, built out over the water and commanding a magnificant panoramic view of the Bay. A short shopping spree in Sausalito shops, before returning to the Sheraton-Palace Hotel, ended the day's activities.

Thursday activities were limited to Coffee and Rolls in the morning, in order to leave the rest of the day free for individual exploration.

Annual Meeting of ASQC

Following are a few of the highlights of the reports presented at the annual meeting that should be of interest to every member.

A. Significant progress has been made in the area of Professional Development. With the formation of the General Professional Council, to coordinate and unify programs designed to enhance the professional stature of Quality Control engineers, the several Committees concerned with these matters are actively developing such programs. Development and documentation of the Work Elements of Quality Control and establishment of a foundation for professional certification are outstanding among these.

B. The Board of Directors has approved the formation of the ASQC Education and Training Institute. Charged with developing, coordinating and directing the operation of the Society's formal educational program, the Institute will bring to members opportunity to benefit from the formal programs and the training material it will formulate. The Management Workshop Seminars represent a modest beginning in this effort; the immediate years ahead should see substantial gains; the Board views the entire educational program of great importance to the membership.

C. In the technical area, important contributions have been made by the Divisions and Technical Committees. The Board has approved the establishment of the Reliability Engineering Technical Committee; the Ad Hoc Committee assigned to lay the foundation for this new Technical Committee has done an outstanding job in building a program and charting a course for the work ahead. Formal organization took place at San Francisco during the Convention.

D. Based on the recommendations of the special committee studying the Society's organizational and functional structure, and the work of a small committee of Past Presidents, a proposed new Governmental Structure was approved by the Board and recommended to the membership for adoption. The new plan provides for increased experience and maturity in the governing bodies of the Society and at the same time, provides for aggressive and expeditious administration of its affairs.

Annual Banquet

The Society's Annual Banquet was held in the Gold Ballroom on Wednesday evening. Following the singing of the National Anthem by the more than 400 members and guests, Reverend Carl Howie of the Calvary Presbyterian Church in San Francisco delivered the invocation.

At the program following the banquet, President Fisher announced the results of the Saddoris Award for Section Management. In second and third places, respectively, were the Montreal and Boston sections. Winner of the competition was the Los Angeles section; the first section to repeat as a winner since the establishment of the award in 1955. Henry I. Matosoff, Los Angeles chairman, received the plaque and banner from President Fisher on behalf of the section.

The Brumbaugh Award was presented to J. Stuart Hunter for the best paper in Volume XV of *Industrial Quality Control*. The title of Dr. Hunter's paper is "Determination of Optimum Operating Conditions by Experimental Methods." It appeared in three parts in the December 1958, and January and February 1959 issues.

At its meeting on Feb. 19, the Board of Directors approved a new Society Award to be called the "Edwards Medal" in honor of George D. Edwards, the first president of ASQC. The honor of being the first recipient of the Medal went to Si Collier, founding member, past president and Fellow of ASQC.

The full story of the Edwards Medal presentation will be given in the September issue.

President Fisher introduced Professor Edwin G. Olds who made the presentation of the Shewhart Medal to Dr. Paul S. Olmstead for his outstanding service to the science of Quality Control on detecting and clarifying assignable causes. Dr. Olmstead's medalist address appears on page 5 of this issue; Dr. Old's presentation remarks follow:

"Postulate 3 — Assignable causes of variation may be found and eliminated."

This postulate is set down on page 14 of a book, entitled, *Economic Control of Quality of Manufactured Product*. The famous author: Dr. Walter Andrew Shewhart, the man in whose honor the Shewhart Medal was first established.

Another quotation — from the writings of a different author:

"In general, engineering data that meet statistical requirements for a state of statistical control are obtained only after eliminating one or more assignable causes."

The source: "How to detect the type of an assignable cause," *Industrial Quality Control*, November, 1952. The author: The Shewhart Medalist for 1959, Dr. Paul Smith Olmstead.

The association of Paul Olmstead with Walter Shewhart began on June 1, 1920, when Paul became a summer employee of Western Electric Company. Prior to that date, according to *American Men of Science*, he had been born in Wilton, Connecticut and had received a B.S. degree from Princeton. Also, he had spent a summer with the Westinghouse Corporation and had worked as a computer at Aberdeen Proving Ground under the supervision of his calculus teacher, Captain Oswald Veblen. These experiences heightened his interest in experimentation and whetted his appetite to learn more about the analysis of data. He was ready to accept the Shewhart philosophy and to begin his long-term investigation of how to detect the presence of assignable causes and how to characterize them.

At the end of the summer of 1920, Paul returned to Princeton as a Queen fellow for graduate work in Physics. His doctoral dissertation, written under the direction of Professor Karl Compton, and published in the *Physical Review* in 1922, reveals his realization of the importance of isolating the causes of nonrandom variation in experimentation.

After a further period of association with the Western Electric Company, Paul was transferred to the

(Please turn to page 32)

ASQC

14th Annual Co

Reading clockwise from upper left:

Henry Matasoff receives the Saddoris Award for
placed second and third. Master Sections having
St. Louis, Northeast Tennessee, Lima, Minnesot

1960-61 Executive directors: (standing) A. W. W

1960-61 Officers: (standing) L. S. Eichelberger, vi
W. R. Purcell, vice president; (seated) R. L. Fiasc

President-elect J. Y. McClure presents a special

Retiring president C. E. Fisher congratulates the

The keynote address, "Let's Keep 'Made in Ameri
the NAM, at the opening session Tuesday morning.

President Fisher presents the section charter to

Martin Brumbaugh, first editor of Industrial Qua
J. Stuart Hunter for the best article in Volume

At the general session on Wednesday morning,
Missiles."

Paul S. Olmstead, Shewhart Medalist for 1959, r
sponsor, introduced Mr. Olmstead.

Qualit

vention and Exhibition

Management for the Los Angeles section. Boston and Montreal sections
ent or better of the top score are: Greater Detroit, Dallas-Fort Worth,
on, Cincinnati, Syracuse, and Greater Muskegon.

Howard Todt, H. D. Birch, (seated) P. S. Olmstead, I. W. Schoeninger.

ident; A. B. Mundel, vice president; M. E. Wescott, chairman, Editorial Board;
reasurer; J. Y. McClure, president, and D. S. Chambers, executive secretary.

of the Board of Directors to John Riordan.

resident, J. Y. McClure.

World's Quality Standard," was presented by Rudolph F. Bannow, president of

E. Ervin, chairman of the new Oklahoma City section.

ntrol, looks on as president Fisher presents the 1959 Brumbaugh Award to
ndustrial Quality Control.

dmiral Paul D. Stroop addresses the Convention on "Reliability of Guided

the medal from president Fisher. On the left is Edwin G. Olds who, as the

Control—The Golden Gate to Higher Profits

1960-61 Society Officers

President
J. Y. McClure
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Bell Telephone Laboratories and, since 1925, has been a member of that organization with responsibilities of increasing importance. At present, he is a consulting analyst on major military projects.

Our 1959 Medalist is a member of a long list of learned and honorary societies. As recognition of his contributions to science, he has been elected to Sigma Xi and to fellowship in the American Physical Society, The American Association for the Advancement of Science, the American Statistical Association, and the American Society for Quality Control. Over the years he has given freely of his time and energy to the promotion of the welfare of these, and other, organizations.

A recital of his services in various official capacities will not be attempted, but it seems ungrateful to omit mention of three examples of his work for our own organization. He labored as a member of the Editorial Board of *Industrial Quality Control* for five years. He is the Chairman of the Management Committee for the new journal, *Technometrics*, and many of you may not realize the amount of effort he has poured into the initiation of that difficult project. Even more worthy of notice is his nurture of the Metropolitan Section. In the week beginning July 31, 1943, an intensive course in Quality Control by Statistical Methods was held at Newark Academy. At the end of the week, the Society for Statistical Quality Control was born. A check-up of the infant after a few months revealed a distressing loss in weight. The future Metropolitan Section registered only seven members. But, at this point Dr. Olmstead came to the rescue and, very soon, it grew to a hundred. Now the reported count is eight hundred and forty-three.

Paul's untiring efforts in spreading the gospel of statistical quality control have not been confined to the Bell organization or even to his Metropolitan Section. There are few, if any, of our districts which he has not visited in response to urgent requests from program chairmen for clinics and conferences. Also, in 1955, he was an Invited Lecturer for the International Statistical Institute at Rio de Janiero.

In view of Dr. Olmstead's success in applying the principles of statistics in research and development work at the laboratories, it is not surprising that he was persuaded to serve as an evening lecturer in Engineering Statistics at Stevens Institute of Technology (1939-42) and in Quality Control for an ESMWT course offered by Princeton at Newark Academy in 1945. Neither is it surprising that, since 1955, he has been Honorary Professor of Statistical Quality Control at Rutgers University.

The effect of the spoken word may lessen with time but the written word lives on and conditions our future. It is fortunate for statistics, and for statistical quality control, that Dr. Paul Olmstead has been willing and able to make so much of his research and philosophy a matter of public record. His long list of writings since 1920 are identified with many journals. Some papers, of course, have been in his field of physics, but most of them either formally or implicitly, are concerned with that search for cause which so early aroused his interest. Look, for example, at his papers in the *Annals of Mathematical Statistics*: "Note on the theoretical and observed distributions of repetitive occurrences," "Distributions of runs up or down of a given length in a random arrangement of a finite series," "A corner test for association" (with J. W. Tukey). Read his paper with A. C. Walker on "Textile yarn abrasive test" and his paper with A. C. Campbell and H. G. Romig, on "Tracking troubles in atmospheric corrosion testing." Study his paper in the 1958 *Bell System Technical Journal* on "Runs determined in a sample by an arbitrary cut." In every case, the ultimate goal is clear, learn to find, and to eliminate, the assignable cause.

It is obvious to those who know him best that this outline of the signal contributions of our 1959 Shewhart Medalist is far from complete. It may suffice, however, to give some indication of the reasons why Paul Olmstead has been chosen to receive our highest award and why I feel deeply honored to present him to you tonight.

New Officers

In concluding the program of the Annual Banquet, President Fisher summarized the activities and accomplishments of ASQC over the past year, after which he introduced the new officers and executive directors (see pages 30, 31):

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J. Y. McClure

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A. V. Feigenbaum
A. B. Mundel
W. R. Purcell

Executive Secretary

D. S. Chambers

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R. L. Fiaschetti

Executive Directors

H. Davis Birch
P. S. Olmstead
Howard Todt
A. W. Wortham
I. W. Schoeninger

In Retrospect

The 14th Annual Convention fulfilled its objective; it was well attended, instructive and entertaining. It gave men interested in quality standards an opportunity to meet and mingle with men of like interests and motivated them to carry its theme back into related fields where men work together for the same purpose and ideals.

Now that the convention is over — except for such mundane things as paying bills — our heart-felt thanks go to the many people who worked so diligently to make the convention a success.

Thanks go first to those who foresaw the potential of a San Francisco Convention, the city's hospitality, tourist attractions, varied industry, and growing interest in quality control.

Second, our heart-felt thanks to the San Francisco section and especially the Convention Committee for the major role it played in planning, programming, and helping to make the convention a success.

Third, we must mention the important role Cal Haws, Western Regional Conference chairman, played both in "spark plugging" and staging the Inspection Workshop, and in getting the sections in the Western Region to support and attend the convention. To stimulate attendance among the sections of the Western Region, Cal established a plaque to honor the section that sent the highest percentage of its members, rated on a special scoring system that included distance traveled.

And lastly, we must give due credit for the fine job our Administrative Secretary, Bill Youngclaus, did in master-minding and conducting this, his first ASQC Annual Convention.

Approximately 40 of the conventioners and their wives took the occasion of the Mid-Pacific Conference in Hawaii as an opportunity to learn quality control Hawaiian style, and to relax a bit in the fine sunshine of our 50th state — a fine aloha to a successful convention.

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VRS-62

Your copy of the 1960 Annual Convention Transactions is waiting for you!

If you were unable to attend this year's convention, you won't want to miss the opportunity of obtaining the vast amount of technical information presented. A limited number of copies of the convention transactions are available on a "first come — first serve" basis. Keep your quality control library up-to-date. Order your copy today!

HERE IS A LIST OF THE PAPERS CONTAINED IN THE 1960 CONVENTION TRANSACTIONS

A Short Survey of Management's Use of Operations Research

Weapons System Management for Quality

The Measurement and Specification of Product Abilities

When is a Small Sample Large Enough?

How to Plan and Implement an Incoming Material Control Program

Statistical Quality Control Applications in the Food Industry

Raising Productivity of Indian Industry Through Quality Control

Calibration Requirements for Government Contractors

Videosonic Instructions Raise Quality Standards

Audit Testing

Variations of Mechanical Properties in Aluminum Products

Air Force Quality Control 1960-1962
Army Progress in Quality Control for 1959
Navy Progress in Quality Control for 1959

Integrated SQC in Food Processing

Some Statistical Concepts Applied to the Navy Calibration Program

Higher Quality—Through—People in Quality—Quality in People

An Approach to a Reliability Prediction Program

Reliability Assurance Provisions in Specifications

Power Characteristics of Control Charts

Life Test—Some Practical Considerations

Good Enough—Isn't Good Enough

Some Economic Aspects of Quality Standards

Quality Control Programs Should Be Cost Reduction Programs

Mechanization, Quality Control and Automation

Company Standards and Quality Control

Automatic Production Recording—Yield—And Quality Control

Sampling Frozen Beef Using a Variable Sampling Plan for Percent Fat

Selection of Flavor Panels for Complex Flavor Difference

How Many Dollars are There in Incoming Inspection Costs?

Total Quality Control Through Reliability

Progress in Professionalism

The Analysis of Variations for Certain Physical Properties of Combed Cotton Yarns

Sampling Problems in the Metals Industry
How Shall We Apply It?
Sampling Problems in the Metal Industries

Statistical Evaluation

A Program for Defining and Controlling Visual Defects in a Multi-Plant Operation

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What's New?

ROY A. WYLIE, *Editor*
Ampex Corporation

P-8-1—An electric indicator which signals "out of tolerance" is now offered in the Kwik-Chek gage line. In this new indicator, an electric signal is generated whenever established tolerance limits are exceeded. The signal can be used to turn on lights or for automatic control. By the addition of an adapter, the light box can be converted to a summarizing box for up to six electric indicators when gaging multiple dimensions. With this arrangement, an out of tolerance condition will be signaled by the "over" and/or "under" light. If all dimensions are within tolerance, the "good" light will signal.

* * *

P-8-3—Two magnetic-particle testing units to provide detection of tiny flaws as deep as one-half inch below the surface are part of the new line announced by Picker X-Ray Corp. One unit is stationary, the other mobile. The stationary unit, called the Ferroscope, provides highly sensitive inspection of production runs of small parts, as well as maintenance of aircraft, machine tools, etc. It detects flaws, seams, critical weld defects and heat treat, grinding, forming and fatigue cracks. It is more compact than most units of the same type and all controls are within reach of the operator. It has 6,000 ampere D.C. output and meets Mil - I - 6867A Type II equipment specifications. The mobile Ferroscope is used to find defects primarily on large rough parts such as forgings, rotor blades, drive shafts and other assembly items that must be checked on the spot. Moving on 8 inch rubber casters, it can be wheeled inside the plant or out into the field. Eye-bolts are provided for both A.C. and half-wave D.C. Demagnetization can be done in 15 seconds, and the portable unit can be operated by remote control.

* * *

P-8-5—The General Electric Recording Spectrophotometer is a precision instrument for measuring the colors of materials. In less than one minute, the instrument draws a continuous spectrophotometric curve (reflectance or transmitance versus wavelength), and with its accessory Automatic Tristimulus Integrator, simultaneously computes color specifications (X, Y and Z in the universally-accepted CIE system). The basic design of the G.E. Recording Spectrophotometer was developed by Professor Arthur C. Hardy at the Massachusetts Institute of Technology. Although primarily intended for measuring the color of reflecting materials, the spectrophotometer has been widely used as a production tool for many types of analytical chemistry, as well as an instrument for scientific research. Typical applications include measurement of the color of textiles, plastics, ceramic tiles, cosmetics, pharmaceuticals, pigments, dyes, paints, inks, paper, filters, appliances, rubber goods, and photographic products. In the Recording Spectrophotometer the various wavelengths of the visible spectrum are successively reflected from a sample and a standard, and means are provided for recording the reflectance of the sample compared with that of the standard (which generally is assumed to be 100 percent). In principle, the instrument is a double-beam spectrophotometer with a double monochromator. The Automatic Tristimulus Integrator is an optional accessory for the General Electric Recording Spectrophotometer. Usually it is mounted inside the spectrophotometer and the two are electrically coupled for synchronous operation. The Integrator automatically calculates tristimulus values (X, Y and Z) while the spectrophotometer is measuring a sample, and immediately afterwards the X, Y and Z values may be read from convenient dials. Essentially the integrator is a mechanical analog computer.

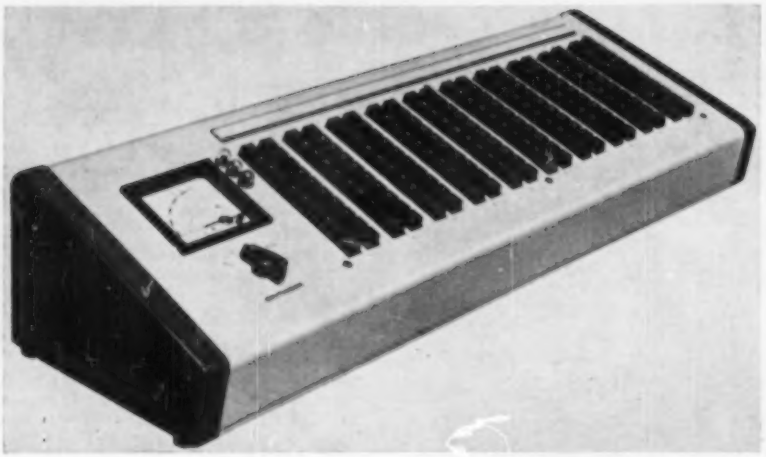
Fourteenth New England Quality Control Conference October 19-21, at Hotel Bancroft, Worcester, Mass.

The Fourteenth New England Quality Control Conference will be held Oct. 19-21, at Hotel Bancroft, Worcester, Mass.

Topics included in the tentative program are Total Quality Control for Small Operations, Management and Statistical Quality Control, and Quality Assurance and Reliability.

In addition, numerous educational sessions and problem solving clinics have been planned.

ASQC sections sponsoring the Conference are Albany, Boston, Buzzards Bay, Hartford, Mid-Hudson, New Hampshire, New Haven, Pittsfield, Rhode Island, Southern Connecticut, Western Massachusetts and Worcester.



P-8-12—This desk top computer gives an instantaneous solution to statistical quality control problems. The raw numerical information is fed into the computer by means of a conventional keyboard. Mean value and standard deviation are immediately indicated on a large panel meter. Accuracy is better than 2 percent. Construction features include all-transistorized circuitry.

Again Available

Transactions of the 1959 Chemical Division

3rd Annual Technical Conference

1959 Transactions include:

Use of Statistical Quality Control Charts in Continuous Chemical Processes, E. S. Aldredge
Some Transformations and Techniques Useful for Graphical Solutions, C. F. Lewis
Determining Sources of Yield Variation in a Multi-step Chemical Process, W. C. Quinn and H. Davidson
Experimental Design — Subdivision of Treatment, M. A. King and F. T. Takenaka
A Field Application of Convariance Analysis, L. D. Pahnke
Effective QC Program for a Knock Rating Laboratory, A. R. Crawford, E. S. McBride and F. W. Kroll
The Grasshopper Program, G. E. Kimball
Estimating the Precision of Test Averages from a Study of Variance Components, E. F. Parmenter
Industrial Application of Non-Parametric Statistics, E. C. Harrington, Jr.
Optical Design Considerations in Response Surface Estimation, J. L. Folks
Variance Components Analysis, A. W. Wortham, J. L. Folks, L. H. Smith
Experimenters, Statisticians and Models, V. B. Shelburne
The Analysis of Means, E. R. Ott
The Analysis of Residuals, L. S. Nelson
Non-Linear Regression, A. W. Dickinson

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Please send me .... copies of the 1959 Chemical Division Third Annual Technical Conference Transactions at $2.50 each.

Name .....

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.....

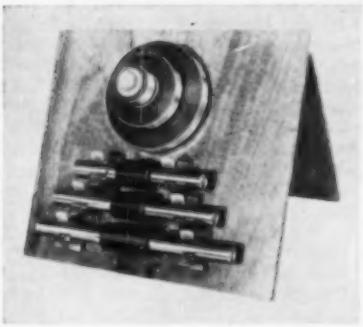
P-8-10—A new high-speed relay analyzer that tests seven different characteristics of electronic equipment in 4 seconds is available from Molectronics Corp. The analyzer provides quick accept or reject information and by pressing a button, various parameters such as coil resistance, pull-in voltage or current, drop-out voltage or current, pull-in time, or drop-out time can be measured. Special lamps are used for the "go-no-go" tests. The lamps will be on for "go" or "good" and will be off for "no go" or "bad". It is not necessary to read any meters or dials. In addition to its inherent capability for production inspection, engineering qualification analysis is provided. Through the use of the automatic cycling feature of this instrument, life testing may be performed at a controlled cycling rate. Five-way binding posts are provided on the front panel for all relay connections. This permits the use of an oscilloscope for contact bounce analysis and the application of loads on the relay contacts for load testing and contact resistance measurements.

* * *

P-8-9—A new and improved hardness gauge, called the Rex Model 1500, for use in measuring hardness of materials such as rubber and plastics has been announced. The gauge indicates hardness in Durometer units that comply with ASTM specifications for rubber hardness. The vernier reads directly to 5 points which permits interpolation to about 2 points with average vision. The runner is pushed down for new readings in a manner similar to a tire gauge. The principal feature of the gauge is the accuracy which is maintained during its lifetime, regardless of the amount of usage. It is ruggedly constructed and can be dropped on a floor without damage. The gauge has a hardened

steel indentor which comes in contact with the material being tested. This indentor pushes up the runner of the vernier by direct contact. The runner is then held by friction so that the instrument can be removed and read elsewhere. Weight is 1½ ounces and the unit is small enough to be carried in a vest pocket. Price with a leather case is $59.50.

* * *



P-8-6—Harolds Gauges, Ltd. of Birmingham, England, offer new gauges for checking micrometers and the individual "feel" of the user. These gauges are conveniently arranged in sets up to 36 inches in size. The micrometer is easily and quickly checked for accuracy and the user can readily sense the feel at the correct reading. The sets comprise spherical rods of ample diameter, ground and lapped for accuracy and long life. Spherical rods or discs are available for sizes 3 inches and under. The smaller rods (up to 8 inches long) are accurate in spherical diameter to ±0.00005 inches. Larger sizes are held to proportionately close tolerances. Gauging a micrometer on such a spherical rod is like gauging on a full sphere. Gauges are mounted on convenient racks for use at locations such as tool cribs, so that every machinist or inspector can easily check his micrometer and his "feel".

* * *

P-8-7—A new accessory in The Sheffield Corporation's line of instruments and systems for precision inspection and assembly is an enclosure, called a "Pre-Fab-Lab," which controls temperature to within one-quarter of a degree Fahrenheit and relative humidity to less than 50 percent. It can be knocked down and set up in 24 hours to provide a truly transferable enclosure that can be moved about a plant at will. Three standard design sizes have been made available. Inside dimensions of standard models are 15 feet x 23 feet; 15 feet x 31 feet; and 15 feet x 39 feet; with recommended ceiling height of 12 feet. Other sizes can be supplied. The "Pre-Fab-Lab" is furnished complete with entrance airlock, air con-

One of many assembly lines of skilled operators employing AO CYCLOPTIC Stereoscopic Microscopes to assemble advanced germanium computer transistors at Texas Instruments vast Semiconductor—Components division in Dallas, Texas.

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Precision assembly of minute components for transistor production offers no problem to the skilled workers at Texas Instruments. Using the AO CYCLOPTIC Stereoscopic Microscope, material that is practically invisible to the eye assumes accurately magnified proportions...the entire assembly operation is observed in crisp, erect, three-dimensional detail.

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When manufacturing small precision assemblies... many progressive companies such as TI, depend upon the AO CYCLOPTIC to render the unit in visual "working size" dimensions.

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ditioning and cleansing system, internal lighting, and two 4 feet x 8 feet access doors on one side so that large size equipment can be moved into the laboratory.

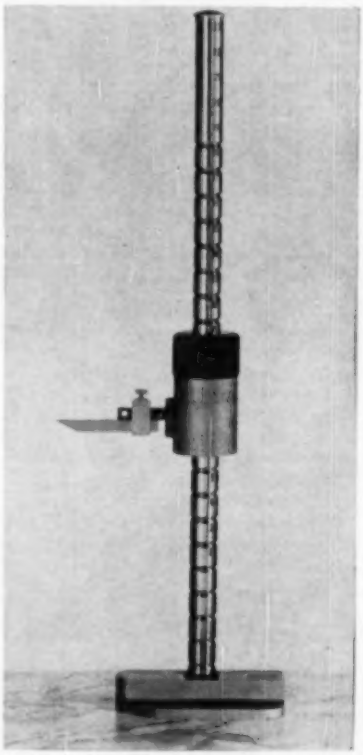
* * *

P-8-8—The new Sunnen Products Precision Hole Gaging Set eliminates need for setting masters. The new set consists of two precision instruments: A comparator type gage and its size setting fixture. One size setting fixture can be used with any number of gages. The set requires no gage blocks, rings, or other "masters" to set, check or gage any hole size within its ⅜ inch through 1½ inch range. This range can be increased to 3 inches through the use of extension fingers. Settings approach the accuracy of gage block transfers, yet are as simple to establish as micrometer readings and entirely independent of the operator's "touch". The portable self-contained Sunnen Gage is sturdily built for every day shop use. Its full-floating reed type mechanism has no racks or gears that can wear and cause inherent errors. 1000:1 magnification makes it easy to read ¼ tenths (0.000025 inches) 0.001 inch equals one inch on the 0.005 inch range, linear scale.

* * *

P-8-4—High accuracy in load measurement, even with an inexperienced operator, is now possible with the Steel City Optical Proving Ring. Load is applied along the axis of the two bosses on the ring. An accurately divided scale contacts the upper edge of the ring and moves up or down through the field of a microscope as the ring is deflected. The microscope is attached to the lower portion of the ring and contains a reticle scale which serves as a vernier, appearing super-imposed over the moving scale. The combination of scales is graduated to twenty millionths (0.00002) of an inch. By estimating to half graduations, readings to ten millionths of an inch are obtained. Readings are taken directly without the need for adjustment during use, and experience indicates a repeatability of 1/20 of 1 percent of full scale deflection. Optical proving rings can be calibrated by the National Bureau of Standards or by the manufacturer. The purchaser receives a copy of the calibration report with which applied loads are translated into deflections. Standard optical proving rings are available in any required capacity to 200,000 pounds. Rings are available for use under compression, in tension, or both.

* * *



P-8-11—The Height Master, a new concept in height gages, is now being manufactured by United States Chemical Milling Corp. An accurate, quick change, multi-purpose gage, the Height Master is specifically designed for use in inspection, precision layout work, and checking jigs and fixtures. The gage gives accurate measurements to 0.0001 inch and eliminates the need for expensive gage blocks and transfer gages. Standard and oversize gages, from 17 inches to 108 inches, with a wide variety of accessories are available.

File it
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This article by Ervin F. Taylor, chairman of the Bibliography committee, ASQC, contains valuable suggestions for numbering and filing your Quality Control literature.

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P-8-2—The new autocollimator for precision measurement of angular position and small linear displacements has been introduced by the Gaertner Scientific Corp. The M550 autocollimator is designed to measure small angles of tilt in a reflective surface mounted in its line of sight. It is useful in providing convenient, fast readouts when measuring the squareness of machine beds and large surface plates and when gaging small linear displacements. Specifications are as follows: focal length, objective 16 inches; aperture 2 inches; magnification of microscope 40 x; range 10 minutes; reads to ½ second; illuminator 6-8 volts; length 26½ inches; width 5 inches; height 5 inches; and weight 24 pounds.

New Literature Available

L-8-1—An instrument selection guide section features the new six-page Non-Linear Systems, Inc. short form catalog on NLS digital voltmeters, ratiometers, ohmmeters, voltage and resistance comparators and associated measuring equipment. This guide compares each NLS digital instrument series by application, features and specifications.

* * *

L-8-2—A 16-page folder describes Leeds & Northrup Company's new convenience styled line of laboratory and testing instruments. Fully illustrated, it contains specifications, application information and prices of six different portable potentiometers, two d-c galvanometers, an a-c and a d-c null detector, a guarded Wheatstone Bridge Facility, a Students' Potentiometer, a Universal Ratio Set and two electrolytic conductivity indicators.

* * *

L-8-3—A leaflet describing a new technical abstracting service in the field of electronic computers is available from Cambridge Communications Corp. Abstracts of papers on computer equipment, programs, and mathematics are printed on 3 inch x 5 inch index cards to provide a cumulative, multiple-entry index to the computer literature. Approximately 2,000 cards will be supplied during the first year of publication.

* * *

L-8-4—Two complete lines of static-dynamic balancing machines are described in a 20 page bulletin just released by the Tinius Olsen Testing Machine Co. The bulletin describes the Olsen compensator and pivoted cradle machines, including special adaptations for jet engines and components, automobile engines and completely automatic balancing machines. In addition, the bulletin includes an informative dissertation on the nature, causes and correction of unbalance with descriptions and schematic diagrams of four different balancing methods.

* * *

L-8-5—The 1960 price list and index of American Standards, published by the American Standards Association, lists nearly 1,900 American Standards that have been approved to date. The fields covered include automotive, chemical, civil engineering and construction, drawings, symbols, abbreviations, electrical engineering, metallurgy, materials handling, mechanical engineering, mining, nuclear, photography and motion pictures, paper, petroleum, rubber, textile, wood, safety, gas appliances and some consumer goods.

* * *

L-8-6—A new 16-page bulletin shows the PC-3A system for precise proportional counting of alpha and beta activity in prepared samples. The system effectively analyzes the radioactivity of compounds with such widely differing isotopes as H-3, C-14, P-32, S-35, K-40, Ca-45, Fe-59, Ni-63, Zn-65, Au-198, Fe-55, Po-210, Th, U and Pu-239. This versatility enables the system to handle a wide variety of work in biological and physical research, environmental sampling, and in mining and ore processing.

* * *

L-8-7—Now available is a fast reading little booklet that introduces Optical Comparators in a relaxed, easily understood manner. Its title "Jones & Lamson Optical Comparators—What They Are—and What They Do".

* * *

L-8-8—New approaches to gauging problems are pictured and explained in Deltronic's 4-page booklet, showing suggested uses of Tenth Plug gauge kits and Precision Micro-Ball gauge kits. Information given is applicable to most other types of gauges, and illustrates methods of shortcutting many normally tedious production and inspection jobs.

* * *

L-8-9—Monroe Calculating Machine Co., Inc., has made available a new handbook, *Monroe Calculating Machine Methods, General Statistics, with a section on Quality Control.* The aim of this booklet is to provide information and instructions that will aid researchers in applying the Monroe Calculator to the figuring work they most frequently perform and to explain methods and short-cuts that will reduce the use of data sheets and the recording of intermediate results.

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ELECTRONICS DIVISION NEWS

Annual Meeting

Thirty members and friends of the Division met for discussion, fellowship and dinner at the Red Knight Restaurant during the 14th Annual Convention and Exhibition, May 24 in San Francisco, Calif.

Arrangements for this happy occasion were made by Eugene L. Brown, District 17, Councillor. During the discussion before dinner Dean Voegtlen, Chairman Elect, presented a brief summary of the overall Division activity for the past year including the short and long range plans for the future. You will get a full report on this in your next newsletter.

Leon Bass Honored

Highlight of the dinner (aside from the fine food) occurred when Chairman Gordon Beckhart called on Bob Fitzgibbons of the Awards Committee to present the Annual Division Award. This year the award was made for outstanding contribution to the Division and was presented to Leon Bass.

For his vision, initiative, and hard work in the initial organization of the Electronics Division, for his role in associating the Electronics Division with the reliability movement, and for his continuous aid and guidance to the Division, we hereby present this award."

Because of his interest and capability in the area, Mr. Bass was named chairman of the Electronic Technical Committee back in 1949. He was thus the founder of what was to become the Electronics Div.

Immediately after its establishment, the committee worked on development of standards of acceptance for electronic components. Mr. Bass worked with associates in IRE, EIA, and AIEE to create a forum for the discussion and promotion of the reliability effort.

From this forum, the reliability symposium was organized eight years ago. Thus, Mr. Bass was instrumental in associating the Electronics Division with the reliability movement from the very start.

He has continued to maintain close association with activity in the Division and has provided assistance and guidance throughout the years.

New Officers and Councillors Elected

The following report of newly elected officers and councillors was made by the Secretary, John Bemesderfer:

OFFICERS

Chairman:
Gordon Beckhart, Radio Corportation of America, Moorestown, N. J.

Chairman Elect:
H. Dean Voegtlen, RCA Service Co., Rome, N. Y.

Secretary:
Harry Shifflett, Texas Instruments, Dallas, Tex.

Treasurer:
John F. Teunisson, Federal Aviation Agency, Washington 25, D. C.

All members are urged to contact their new representative on any new activities or ideas they may have relative to Division affairs. Remember the Division's primary purpose is to serve you adequately.

COUNCILLORS

District 1:
Frank West, Clarostat, Dover, New Hampshire

District 2:
Frank A. Gall, General Electric Co., Utica, N. Y.

District 3:
George Scheel, Sonotone, Elmsford, N. Y.

District 4:
Robert J. Wallace, RCA Victor, Montreal, Canada

District 5:
Allan B. Gurney, International Resistance Co., Philadelphia, Pennsylvania

District 6:
Arthur R. Roddey, Institute for Defense Analysis, Washington, D. C.

District 8:
William E. Smith, National Cash Register, Dayton, Ohio

District 9:
Edward L. Bower, Bendix Products Division, Mishawaka, Indiana

District 10:
H. H. Estes, Chrysler Corp., Detroit, Mich.

District 11:
Martin Joseph, Kellogg Division, IT&T, Chicago, Ill.

District 12:
Vida Grace Hildyard, Remington Rand Univac, St. Paul, Minn.

District 13:
John A. Duggan, Bendix Aviation Corp., Kansas City, Mo.

District 14:
Herbert B. Epstein, Chance Vought Aircraft, Dallas, Tex.

District 15:
Harold Z. Snyder, Minneapolis-Honeywell, St. Petersburg, Fla.

District 16:
Herbert J. Coughran, Magnavox Co., Los Angeles, Calif.

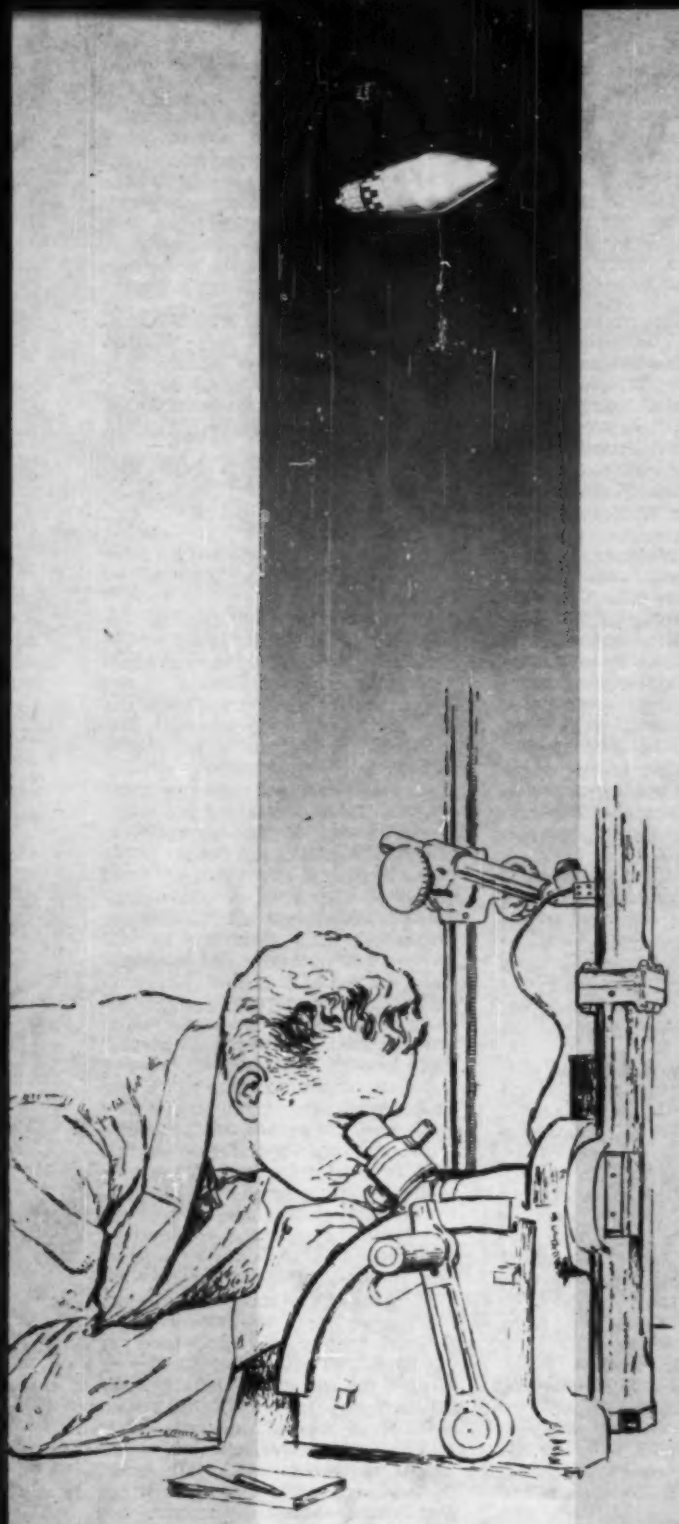
District 17:
Eugene L. Brown, Lenkurt Electric Co., San Carlos, Calif.

Reliability Conference Oct. 10-15

A Reliability Training Conference will be sponsored by the ASQC Electronics Division and the PGRQC of IRE the week of Oct. 10-15. It will be held at the Lake Texhoma Lodge, near Kingston, Okla., north of the Dallas-Fort Worth area.

Evening speakers and conference leaders will include top reliability managers and practicing engineers from government installations and major companies in the aircraft missile systems and components industries.

For additional information, see Clinics, Conferences, and Courses, page 55, this issue.



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BOOK REVIEWS

W. D. Baten, Editor

26 University Drive, East Lansing, Mich.

INTRODUCTION TO PROBABILITY AND STATISTICS, by B. W. Lindgren and G. W. McElrath, The Macmillan Company, New York, $6.25, pages xiii-277. Reviewed by Dr. Joseph J. Moder, Georgia Institute of Technology.

This book, as stated by the authors, is intended to serve as a text in a one-quarter or a one-semester course in statistics for undergraduate students who have had mathematics through integral calculus. To this end, it should be reasonably successful. The authors are in the fields of mathematics and engineering respectively, a fact which is readily apparent on reading this book; it is both rigorous and application oriented. The book has a number of illustrative examples and problems (with answers) which are slanted toward engineering and quality control, however, many instructors woud probably prefer more material in this category.

In writing this book, the authors have selected topics which are fairly standard for a first course in modern statistics without attempting complete coverage of this subject, hence its reasonable size of 277 pages. The book does contain a treatment of some "extra topics", perhaps at the expense of a more thorough treatment of the "standard" techniques.

The book is generally clear, concise, and rigorous. With regard to distribution theory, it treats the delicate questions of discrete probability functions and continuous density functions very nicely. The treatment of these functions along with a treatment of distribution functions is relatively thorough as it should be for persons interested in some of the broader applications of statistics as in operations research, reliability, etc. For example, the Poisson distribution is given its proper place and is derived and applied as a distribution in its own right. The material of combining random variables is also handled quite well.

The treatment of descriptive statistics is quite terse which seems appropriate for a course where so many important concepts must be covered in a short period of time. Readers looking for a simple working knowledge of descriptive statistics will not be interested at all in this book.

The testing of hypothesis is presented fairly well from a theoretical point of view with the emphasis being placed on the OC curve for each test — the book gets away from the typical presentation which emphasizes the problem of analyzing the already (and usually improperly) collected sample. On the negative side, the discussion of estimation is scattered throughout the text and the discussion of the common tests of hypothesis leaves something to be desired as to procedure.

The final chapter, entitled "Some Further Topics" contains material which should whet the appetite of many readers for further study in statistics. It contains a brief but lucid treatment of sequential testing, regression, analysis of variance, and decision theory.

This book contains its share of printers errors, a few instances of inconsistency of notation and errors in the answers to problems. Two methods of pooling variances are discussed, one on page 194 and the other on page 208, the latter method being incorrect.

This book should be of interest to persons starting out in statistics as well as those with some elementary statistical background who want to sharpen up some of their notions about probability and statistics. It should also be of interest to educators of engineering students whose mathematical preparation is ideal for this book.

APPLIED STATISTICS FOR ENGINEERS, by William Volk, published by McGraw-Hill Book Co., Inc., New York, N. Y., xi plus 354 pages, $9.50, 1958. Reviewed by John H. MacKay, Georgia Institute of Technology.

As the author indicates in his preface, this book is designed for the individual interested in statistical techniques and applications rather than in statistical theory. One is not surprised therefore to discover that no precise definition of a random variable is given, or that the notions of expectation, best test, etc., are omitted. These omissions are mentioned in order to indicate the level of sophistication of the book.

The first four chapters (pp. 1-73) introduce the laws of probability (multiplication, addition, conditional probability) in a clear and careful manner. Permutations and combinations are discussed, and binomial, Poisson and normal probabilities are presented, together with the usual computational tables and graphs. The standard measures of location and dispersion are presented.

Chapter 5 (pp. 74-97) gives a discussion of chi-square as applied to ratios, contingency and goodness-of-fit. The uses of Student's t are presented in Chapter 6 (pp. 98-135) where mention is made of the central limit theorem and the notions of power of a test and confidence interval are introduced.

Analysis of variance is the subject of Chapter 7 (pp. 136-223), which is a long chapter covering tests of equality of variances, confidence intervals for variances, homogeneity of variances (Bartlett's test), and equality of means. Models I and II for analysis of variance are discussed, as well as Model III (polynomial regression). In addition to discussing analysis of variance for situations differing with respect to numbers of factors, subgroupings, classifications and replications, the author also introduces factorial experiments.

In Chapter 8 (pp. 224-295) on regression, the author discusses significance tests and confidence intervals for the slope in linear regression, comparison of several slopes, etc. Multiple regression and deletion

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of variables are discussed and orthognal polynomials applied to curvilinear regression.

In Chapters 9 and 10 (pp. 296-340), sequential tests for percentages, 2 x 2 tables, means and standard deviations are described. Brief discussion is given of rank tests (e.g. Wilcoxon's), sign tests, the range test, and estimation of standard deviation from the range.

The pedagogical technique of following each new method with a numerical example is a good one. The examples all have chemical flavor which should appeal to the intended audience, and the book should be a useful reference for the unsophisticated reader.

There are several places where the student may be led astray by incomplete statements of propositions or theorems. The statement of Bayes' theorem (p. 7) omits mention of the fact that the sets B_i are assumed exhaustive (as well as disjoint). The statement that s is the "best" estimate of σ (p. 63) should be amplified since s, according to several standard criteria, is far from "best."

Two things might be presented more clearly: the null hypothesis for chi-square test (p. 77), and the conditions under which normality of observations may be assumed for various purposes, including Student's t (p. 102). Also, the untrained reader might be misled by a formula for the variance of an arbitrary function of independent random variables (p. 141). The fact that this formula is only approximate (except in the linear case) is nowhere mentioned. As applied in the first example to the function X_1X_2 of independent variables with vanishing means, the formula in question yields zero as the variance instead of the true value, $\sigma_1^2\sigma_2^2$.

In spite of these few deficiencies the book should be a valuable elementary test and reference.

PRACTICAL STATISTICS IN EXPERIMENTAL DESIGN by A. W. Wortham and T. E. Smith, Dallas Publishing House, Dallas Tex., pages iii-128. Reviewed by W. D. Baten, Michigan State University, East Lansing Mich.

This small book illustrates by many examples how to find averages, variances, confidence limits for averages, how to test averages for significant differences, how to carry out analysis of variances for 1, 2 and 3 classification designs, and for designs where there is more than one item in each "cell", how to analyze Latin squares, Graeco Latin squares, split plot experiments and factorial designs.

The book contains the following tables: random numbers, accumulative numbers, t-values and F-values.

There are sufficient explanations on how to compute the various sums of squares for analyses of variances. This book should give the reader a good deal of information on how to apply analyses of variances to many industrial problems.

I think the authors haven't been too clear on how to test various averages after an analysis of variance has been carried out. The book is easy to read and shoud furnish valuable information on the above material.

ANALYSIS OF INDUSTRIAL OPERATIONS, Edward H. Bowman and Robert B. Fetter, editors. Richard D. Irwin, Inc., Homewood, Ill., 1959, 485 pages, $7.95. Reviewed by Paul Peach, Lodi, New Jersey.

This book is a collection of 26 papers, of which 18 were published originally in *Operations Research* or *Management Science*. The remaining eight are scattered, one of them being an MIT master's thesis. There are five parts: Applications of Linear Programming, Other Programming Applications, Waiting Line Applications, Applications of Incremental Analysis, and Total Cost and Value Models.

The list of authors includes most of the better-known names in Operations Research.

Expected readers are graduate students in management science who need to study case histories to supplement or illustrate theoretical courses. The case histories are drawn from a great many areas: for scheduling only we have applications to metal working, petroleum products, chemicals, employment (2 papers), and rubberized fabric.

The quality of the papers included is pretty uniformly high: not perhaps surprising, as the editors presumably had access to the whole OR literature up to 1957. The coverage is well distributed among the basic problem types: linear programming and allocation, inventory, and queuing. Maintenance is not discussed as such, but the book includes two papers on spare parts management, one of which presents some interesting data on demand for aircraft parts.

The mathematical level varies from paper to paper, but is on the whole rather advanced (making occasional use of finite difference methods and matrix manipulations, as well as more widely known calculus). The papers are thus well adapted to the intended readership: college students whose mathematics is still fresh, who will study each assignment carefully and take time to work through the proofs. Other readers should be prepared to expend a comparable amount of effort.

There is no index, but each paper is preceded by a summary giving "points of interest" and these should be adequate to guide the general reader.

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Controlling Product Quality—Its Value to Industry

The Annual Conference of the European Organization for Quality Control will be held at Church House, Westminster, London, SW1, on Sept. 1-3, 1960. Its title will be "Controlling Product Quality—Its Value to Industry."

The Conference is designed to lead to a clearer understanding of the fundamentals of the control of product quality. It will appeal equally to industrialists interested in applying quality control techniques and to those already applying them.

This will be the first occasion on which the annual conference of the EOQC will have been held in Britain and the first occasion on which such an eminent, internationally-renowned team of speakers on the subject of Quality Control will have appeared on the same platform in that country.

On Thursday, Sept. 1, the Conference will be opened by F. J. Erroll, MP, Minister of State, Board of Trade, and Sir Bertram Waring, DL, chairman and managing director, Joseph Lucas Ltd., and deputy chairman, British Productivity Council.

First session topics will include "Quality from the Viewpoint of Management," by Chairman G. Ronald Pryor, president, Institution of Production Engineers; "The Value of the Control of Product Quality," by Mr. F. Nixon, president, EOQC, and chief quality engineer, Rolls Royce Ltd., Derby, England; "Establishment of a Realistic Quality Level," Dr. W. Masing, vice president, Deutsche Arbeitsgemeinschaft fur Statistische Qualitatskontrolle, and managing director, Haus Nibelungen, Erbach den Odenwald, West Germany.

In the afternoon, "Achievement of the Established Quality Level," Paul Clifford, director of education and training, ASQC, and professor of mathematics, Montclair State Teachers' College, New Jersey.

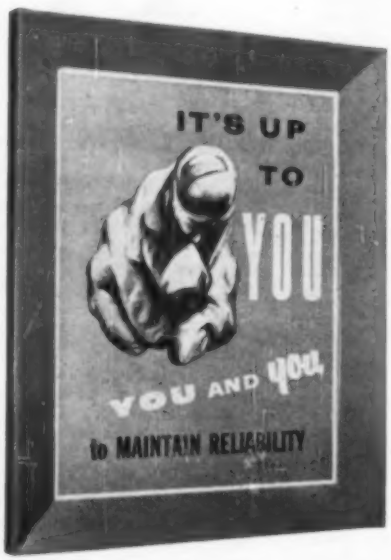
Second session topics will include "Reducing the Cost of Inspection," by Chairman M. J. Mothes, vice president de l' Association Francaise pour le Controle de la Qualite, and "Developments in Qualitative Methods of Inspection," M. E. Befahy, chief metrologist, Ministry of Economic Affairs, Brussels, Belgium.

The morning of Sept. 2, "Developments in Quantitative Methods of Inspection," by M. R. Rambach, lecturer and Consultant in industrial statistics, Paris, France.

Third session topics will include "Diagnosis of Trouble in Manufacture," by Chairman A. J. de Jong, president, Netherlands Statistical Society, and QC engineer, Lever's Zeep Maatschappij NV, Vlaardingen, Netherlands, and "Using Frequency Distribution for Diagnosis," by Dr. A. Palazzi, head, metallurgical and process chemistry, Department, Instituto Siderurgico Finsider, Genoa-Cornigliano, Italy.

In the afternoon, "Short Cuts to Diagnosis," Dr. Ellis R. Ott, director, Rutgers • The State University, New Brunswick, N. J., and "The Economy of Planned Investigations," by D. R. Cox, statistics department, Birkbeck College, University of London, England.

The morning of Sept. 3, "New Concepts in Quality Control," by Chairman M. A. Vincent, Directeur-General Des Papeteries de Belgique, Brussels, Belgium. "Evolutionary Operation," and "The Concept of Integrated Control of Product Quality," by J. van Ettinger, president, Netherlands Foundation of Quality Control for Industry, and Director, Bowcentrum, Rotterdam, Holland.



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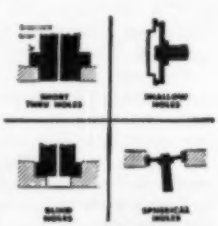

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REQUEST BULLETIN 50

section briefs

ALBANY . . . The Albany section co-sponsored a Symposium with AIIE, ASA, and MORG on May 12. A two-series program running concurrently was presented. The first series was conducted by A. Loellner, statistical laboratory, General Electric Co., who discussed the "Basic Theory of Evolutionary Operations," and Donald Wright, Eastman Kodak Co., who spoke on "Applications of EVOP to the Paper Industry."

The second series was conducted by N. V. Reinfeld, National Management Institute, on "Industrial Applications of Mathematical Programming," and Irwin D. J. Bross, Roswell Park Memorial Institute for Cancer Research, on "Major Public Decisions: Application to Automobile Accidents."

The after dinner speaker was Robert Mitchell, General Electric Co., whose subject was "How Do You Build a Man With the Capacity to Carry."

This was certainly an interesting and successful venture. Our hats are off to the members who made this possible.

Section officers for 1960-61 are chairman— M. Moscinski, Watervliet Arsenal; vice chairman — M. B. Lindquist, General Electric Co., S.A.C. Dept.; secretary — M. P. Flannagan, Marchants Calculator Co., and treasurer — P. Paniszczyn, Silicone Product, General Electric Company.

ALBUQUERQUE . . . The annual spring banquet of the Albuquerque section was held in the Paddock Room of the Silver Spur restaurant on the evening of May 9. At this annual affair, members and their wives and guests enjoyed a steak dinner and a talk by Ralph L. Edgel, director of the Bureau of Business Research at the University of New Mexico.

Mr. Engel's subject, "The Future of Albuquerque and New Mexico," was highlighted by a hand-out of economic statistics for the last 50 years and an invitation to the audience to make their own forecast based upon the data and factors presented in his talk.

ALLENTOWN-BETHLEHEM . . . During the May meeting at the Hotel Traylor, two section members conducted discussions. Charles Pratt, Laureldale plant, Western Electric Co., spoke on "Quality Control of Wallastonite," a discussion of the control of batch processes. Alex Hanfmann, Allentown plant, Western Electric Co., spoke on visual inspection as related to statistical QC. This meeting developed into one of the most interesting of our 1959-60 program season.

The big news here is the rapid development of our Reading, Pa., sub-section! At the suggestion of our executive committee, the Readingites have been pushing for their own section. An organizational meeting was held on May 24, at which officers were elected. In attendance were 17 ASQC members as well as 13 prospective members. Necessary committees, as well as key men, were immediately appointed and Reading is off to a flying start!

BALTIMORE . . . Dorian Shainin, vice president and director of statistical engineering, Rath and Strong, brought his practical approach to solving management's reliability problems to more than 60 members and guests at the closing meeting. In his talk, "Management Faces Reliability Requirements," he emphasized that for effective results reliance on feedback information from field malfunctions and failures should be minimized. Instead there should be reliance on results obtained from analysis of the causes for product failure in the plant and laboratory.

Officers for the 1960-61 season are R. G. Hutter, chairman; D. Taylor, vice chairman; J. W. Kulp, secretary, and H. Ellner, treasurer. A vote of thanks is in order for outgoing officers. Mr. F. Cullen, 1959-60 chairman, remarked that his job was made easy because of the capable performance of the other officers and executive committeemen.

Pictured at the Battle Creek-Kalamazoo section meeting Apr. 21 are Wm. A. Golomski, ASQC Saddoris Award chairman, and 1959-60 section officers—George Church, chairman; A. F. Damon, vice chairman, and Clarence Oranje, secretary. Mr. Golomski explained how "You Can Understand Operations Research."

BATTLE CREEK-KALAMAZOO . . . Officers announced at the May 19 Ladies Night meeting are Arthur F. Damon, chairman; Clarence Oranje, vice chairman; Ralph Anderson, secretary, and George Vaught, treasurer. Chairman for the 1959-60 season was George Church.

Committee chairman are Deland Davies, auditing; Peter Koets, Section Briefs reporter; Eugene Conolly, membership; W. D. Baten, professionalism and examining; Donald Byro, program; James Monk, publicity, and William Shidele, Saddoris Award.

CINCINNATI . . . At the May 18, joint meeting with the Hamilton-Middletown section, W. E. Smith, foreman, statistical QC department, National Cash Register Co., discussed "Practical QC at the National Cash Register Co." Mr. Smith discussed the training of the QC section, SQC techniques at work, and quality organization and cost control.

Jack Gantt, a member of the ASQC professionalism committee, discussed "Professionalism in ASQC" for the coffeetalk meeting.

Twelve students from the spring educational series attended the technical meeting and were awarded certificates of graduation by Dick Race. Among the guests were seven representatives of local management, who attended the presentation ceremony of their student employees.

Leon Bass was awarded the Electronics Division Award for Meritorious Service. The award was presented at the annual Convention and Exhibition in San Francisco. The award is given annually for significant contributions to the advancement of the science of reliability and quality control and the application of this science to the electronics industry.

SECTION CALENDAR

Dallas-Fort Worth
Aug. 18, Texas Instruments, Apparatus Division, 7:30 p.m., "Modern Electronic Components," by L. C. Craig, Texas Instruments, Inc., Dallas, Tex.

Dayton
Sept. 8, Delco Lodge, E. Dorothy Lane, social meeting.

Donald W. Mueller, chief inspector, DoALL Co., discussed surface plates and accessories during the class in Precision Measurement which was sponsored Apr. 5, by the Chicago ASQC section.

CHICAGO . . . More than 60 persons representing 25 companies in the greater Chicago area attended the annual Precision Measurement course, sponsored April 5, by the Chicago ASQC section.

The course was conducted at the DoALL Company Hall of Progress in suburban Des Plaines, Ill. A graphic record in the Hall of Progress depicts man's ascent up the ladder of material welfare.

A central feature is a 30-foot-high exhibit, "The Dawn of This Age." It is a "circular history book" depicting 157 significant inventions of the Industrial Revolution. Designed as a "Sunburst," it is symbolic of the explosive, expanding and radiating character of this swift transition to the machine and power age after centuries of a hand-made, muscle-powered economy.

This imposing exhibit is flanked by historic machines that played vital roles in developing the present age of material abundance. They include man's first power plant, an original James Watt model 1799 steam engine, and the only full-size replica in the world of man's first machine tool, the boring mill, invented in 1775.

In another part of the Hall of Progress the class saw The DoALL Company's Demonstration-Test Center, where tests in cutting and finishing all kinds of material are conducted for industry, and its gage demonstration laboratory.

Samuel Richards of the Hammond Organ Co., chairman of the ASQC Precision Measurement course, presided. Milton Hlava of the DoALL Company addressed the class on the historical exhibits in the hall, delineating how man's progress has been the result of his development and use of tools, from the caveman's first fist ax down to the more modern machine tool.

Thomas W. Mitchell, QC manager, DoALL Co., delivered a color slide presentation depicting the quarry-to-customer operations in the manufacture of black granite surface plates. The technical course material was presented by Donald W. Mueller, chief inspector, DoALL Co.

Mitchell and Mueller have collaborated as instructors for six of the 16 class sessions that comprise the 1959-60 course season.

COLUMBUS . . . Our section's last meeting of the current year was a plant tour of the Western Electric Co., one of the newest members of our community. The tour afforded an opportunity for the large turnout of members and guests to see all of the various products and techniques, many of which are entirely new to this area. Refreshments of coffee and doughnuts were served at the conclusion of the tour.

CUMBERLAND . . . "Industrial Experimentation," was the topic of our May 5 dinner meeting at the Shrine Club. Robert L. Brickley, quality assurance manager, Semiconductor department, Westinghouse Electric Corp., was our speaker.

Officers and committee chairmen for the coming season are Martha L. Phillips, chairman; Robert G. Walters, vice chairman and program chairman; Howard (Jack) Price, secretary-treasurer; Theodore J. Kight, membership chairman; George R. Mease, Saddoris Award chairman, and Thomas F. Costello, publicity chairman.

DALLAS-FORT WORTH . . . J. A. Mazzola, manager of product engineering services, IBM, gave a very interesting presentation on "Statistical Dimensioning," at the section's regular meeting May 26. Our attendance was rather light since many of our regular attendants were at the National Convention and Exhibition in San Francisco, California.

On May 7, the section planning committee met at the Western Hills Inn to plan the activities of the 1960-61 fiscal year. This meeting was very successful. Several new faces will be heading committees this year. We are always glad to see new blood among the leaders of our section.

We are eagerly looking forward to a tour of the Fort Worth Star Telegram in July and of Texas Instruments Apparatus Division in August.

DAYTON . . . "Process Improvement Through EVOP" was the theme of Dr. Frederick A. Sorensen's address to the Dayton section members at their annual dinner meeting on May 19. Dr. Sorensen's talk opened a new field in the use of statistical QC and provoked a number of questions. Chairman James M. Cogar reviewed the highlights of the section's activities for the year and introduced the new officers.

HARRISBURG . . . The Harrisburg section monthly meeting was held May 4, at the Castigilia Restaurant. This was Management night, and the speaker was Rocco Fiaschetti, manager, film QC, Ansco, Division of General Aniline Film Corp., Binghamton, N. Y.

Mr. Fiaschetti emphasized the need for communication through dynamic reports and procedures, product uniformity essential methods, business manufacturing reports, and rating systems. Quality control must have a goal which can reduce waste and customer complaints as well as supply machine capabilities of the new products being perfected and thus produce a top quality QC operation.

HUNTSVILLE . . . For the May meeting, the section was the guest of the Chemstrand Corp., Decatur, Ala. Fifty-five section members and their guests enjoyed dinner in the Company dining room. Following a brief meeting, the group was conducted on a tour of the plant. Mr. St. John Courtnay of the Chemstrand Corp., section vice chairman, was program chairman for the tour.

JOPLIN . . . The monthly meeting was held in Springfield at the Ash Grove Lime and Portland Cement Co. A tour of the plant was followed by dinner and a discussion of the technical aspects of the lime and cement business.

LEXINGTON . . . Our May meeting was combined with ASTME. Dr. J. D. Hanawalt, vice president of Dow Chemical Co., was our speaker. Dr. Hanawalt is considered to be the world's foremost authority on magnesium. His topic for the evening was "The Industrial Development of Magnesium." Sixty-nine persons attended the meeting.

A 15 minute show on television station WLEX-TV was conducted by members of the Quality Assurance Office of the Lexington Signal Depot. Participants were

William Akers, Robert Nichols and Archie Dedman. A lecture on how SQC is used at LSD was given by Mr. Dedman. A panel discussion followed the lecture.

LOS ANGELES . . . "It can be done," or "We did it before and we can do it again," seem to be fitting mottos around the Los Angeles area. Yes, for the first time, a section has had a repeat performance in winning the Saddoris Award for section management. This is a fine tribute to a well-conducted program under the management of Henry Matosoff, section chairman. Mr. Matosoff made committee assignments that would assure the proper balance of sectional activity — Jack Lancaster on membership, Ray Primmer on publicity — to name a few.

The proof of exceptional management comes tacitly from the points which are accumulated on a monthly basis. The section chairman's choice of Les Gideon as Saddoris chairman resulted in very few points not being counted. No section in the past has ever been such a decided winner; the LA section was nearly 3000 points ahead of second place Montreal. The fine support and broad coverage of activities will be continued during the coming year — promises Mr. Lancaster, our incoming chairman.

MID HUDSON . . . The May meeting was held at the Flamingo Restaurant, Saugerties, N. Y. An industrial consultant, W. C. Carter, spoke on "Mal-Distribution — Key to the QC Effort." His talk was presented in a clear, concise and interesting manner. He compared the value of a road map in travel, the application of grease to a squeaky wheel, and the need for sign posts to illustrate the proper path to follow in a good QC program.

MILWAUKEE . . . The evening of May 23, section members were guests of the Miller Brewing Co., Milwaukee, Wis. The evening began with a very interesting plant tour. The refreshment, a highly quality controlled product of our host, was enjoyed during and after a movie of the Milwaukee Braves Baseball Club.

A short annual business meeting was highlighted by reports from committee chairmen and officers concerning accomplishments during the past year. Newly elected officers were introduced as follows: Larry Neuman, chairman; Darrell Schroeder, vice chairman; Riley Kelhofer, secretary; Raymond Wachniak, treasurer, and George Craycraft, director (junior past chairman).

MONTREAL . . . F. Alex Gnaedinger, superintendent of production control, Canadian Celanese Limited, Drummondville, Quebec, spoke on "Pencil, Paper and Prophets," at the meeting May 18. His uncle, Paul Gnaedinger, who was moderator for the evening, suggested that "Prophets" could be spelled in another way.

Mr. Gnaedinger is a recognized speaker on textile applications of statistical QC, and his many years experience in the field of textile QC brought much practical information to the members.

Allan P. Deacon, Deacon Associates, Brantford, Ontario, ASQC executive director, was present and spoke at the meeting. He gave some information concerning awards and amendments to the Constitution of the Society and answered many questions.

NORTHEAST TENNESSEE . . . The fourteenth general membership meeting was held in the Dogwood Room at the Giant Supermarket in Bristol on Wednesday, May 11. At 6 p.m., Dr. Hubert Hill, section chairman, gave a brief presentation on application and use of Cumulative Sum Charts. A steak dinner was served at 7 p.m. After dinner, J. F. Verigan, QC manager, Ormet Corp., spoke on "Interesting People in QC." He described incidents in which human relations played an important part in implementing QC.

The section was favored by the attendance of Chester T. Raymo, District 15 representative, at this meeting. This was the last general membership meeting of the season.

On May 19, the incoming and outgoing officers, directors, and committee chairmen met with their wives in Skoby's Restaurant, Kingsport, Tenn. Plans and programs for the coming year were prepared at this meeting.

OKLAHOMA CITY . . . The Oklahoma City section was formed Jan. 14, 1960, with 60 members and applicants. The first business conducted was the election of officers. Directors are Clinton H. Brandt, deputy director for quality, Directorate, Maintenance Engineering, Oklahoma City Air Materiel Area, and R. W. Childress, supervisor of QC, Sylvania Electronic Tubes, Shawnee, Okla. Also, chairman — Lloyd E. Ervin, QC supervisor, Oklahoma City Air Materiel Area; G. E. Gastineau—QC specialist, Oklahoma City Air Materiel Area; secretary — A. G. Schricker, chief of statistical QC, Western Electric, Oklahoma City, Okla., and treasurer — M. E. Thornton, electronic QC inspector, Oklahoma City Air Materiel Area.

The section devoted its first meeting to a series of "get acquainted" talks presented by the representatives of Sylvania, Western Electric, and the Oklahoma City Air Materiel Area. The second meeting featured a speech by James Lawson, Western Electric. He spoke on "Management's Approach to QC."

The section is making plans to sponsor some basic QC educational courses in the fall.

OMAHA-LINCOLN . . . The section met May 13, at Jack's Cafe in Columbus Nebr. After a smorgasbord dinner, the group visited Dale Products Co.

ORANGE . . . Dr. Harry Romig discussed in general many of the variables encountered in reliability determinations. This was augmented by a series of charts that clearly displayed the dramatic effect sample size and

Earle C. Smith, Chief Metallurgist Director of Research, QC Pioneer

The Cleveland Section regretfully announces the death on May 20 of one of its pioneer members, Dr. Earle C. Smith, Chief Metallurgist and Director of Research of Republic Steel Corporation. His sudden death at age 69 resulted from a heart attack.

Dr. Smith

One of the most widely known Metallurgical figures in the world, Dr. Smith had served on many metals advisory boards and committees. He was a member of that group which, in Pittsburgh in 1938, initiated the steps that put modern statistics to work in the steel industry, the first application on an industry-wide basis. From his activities during World War II with the War Production Board he recognized the potential impact of modern Quality Control on not only the steel industry, but on all industry in general.

With his activities always in the background, he was an ardent proponent and vigorous supporter of the actual founding of ASQC and its steady development. His behind-the-scenes support in many industries was almost evangelistic in nature. The Society owes Dr. Smith a deep debt of gratitude. In his passing we have lost a true friend.

percent defective had on the validity of the results. He also discussed briefly a recent meeting in Washington, D. C., on "Interchange of Data," and its legal aspects.

A plant tour of the Hughes Semiconductor Division in Newport Beach is planned for the August meeting. This operation has an extensive night shift operation which will enable the members to view the manufacture of this complex product. Qualified guides will be available to explain all facets with special emphasis on the QC methods used.

PARKERSBURG . . . The executive meeting for May was held at the Blennuhossett Restaurant in Rockland, Ohio. Executive board members were guests of Larry Parker, section chairman.

The May meeting was Ladies night and our annual dinner date. Thirty-five members and guests were treated to a steak dinner at the Chancellor Hotel in Parkersburg, W. Va., on May 11. Dinner was followed by the regular meeting and a talk by our speaker, Dr. A. C. Rosander, Internal Revenue Department, Washington, D. C. His subject was probability statistics in tax operations. A very lively question and answer session followed the talk. This was our last meeting of the season.

PHILADELPHIA . . . The activities of the season were officially closed at the May meeting. E. G. Budd, Jr., president and director of the Budd Co., delivered a fine talk with an important message for all QC minded persons. One of the highlights of his message was the fact of the increasing foreign car market in this country and the decrease in export of our cars to other countries. Mr. Budd made an appeal to ASQC for help that he thought our organization could provide to reduce costs by improving quality.

E. G. W. Johnston, Ford Motor Co., and Stanley Wirtschafter, U. S. Gauge Co., section members, delivered the technical presentations after the dinner. Both men kept the members genuinely interested and the many questions kept the sessions going beyond the normal closing time.

Keep Saturday, Sept. 10, open for the Fifth Annual Symposium on Quality Control Methods and Management. Philadelphia Textile Institute is the host this year and their new facilities will be enjoyed by all who attend. The committee for the symposium is having regular meetings during the summer to insure the success of this program.

PITTSFIELD . . . The May dinner meeting was held at the Stanley Club. The meeting was very well attended and the dinner elicited favorable comments from the members. After the dinner, Brent C. Jacob, Jr., gave an extremely interesting talk on "QC from a Management Viewpoint."

On May 18, an executive committee meeting was held at Fred Hartwell's home to discuss plans for the coming season with the incoming section officers.

ST. LOUIS . . . On June 7, members of the St. Louis section flew from St. Louis to Marion, Ill., to meet with the Southern Illinois section. During the meeting the Southern Illinois section was presented the ASQC charter.

The program was presented by the St. Louis section. Arnold Braun, Ralph Manring, and Murray Whitehead, participated in a panel discussion entitled, "How a Particular Process Problem is Investigated and How the Solution is Attained."

Since this year's QC courses for the Air Force were so successful, three more will be presented next year — one intermediate and two basic.

The newly organized Washington University student chapter of the ASQC has enrolled 31 members. St. Louis University is now in the process of organizing their chapter. The section has made a bid to hold the 1965 National Convention in St. Louis.

Thirty-two members and guests attended the dinner and plant tour of the Shell Oil Refining Co., Wood River, Ill., on May 20. The detailed tour of the refinery included some of their more intricate distillation units, the Analytical and Testing sections of the Laboratory, and their 650 Computer.

SAN DIEGO . . . Members are still talking about our recent meeting which was highlighted by the excellent lecture on "High Energy Forming," given by F. A. Monahan, manager of Development and Process Specifications, Convair, San Diego, Calif.

Vacation time is on us again, and judging by the water ski traffic on Mission Bay, as well as San Diego Bay, one would think all of our out of town visitors are bringing two sets of water skis.

Who were those "landlubber" section members who became quite nautical and ran their cabin cruiser under the dock at the yacht club? The *quality* of their seamanship is questionable!

Our section representation at the National Convention in San Francisco was good, with 20 section members taking advantage of the excellent convention presentations, as well as partaking of the San Francisco night life.

The annual Installation Dinner Dance is practically upon us — so get your tickets early!

Adios Amigos!

SAN FRANCISCO . . . The 14th Annual Convention and Exhibition held in San Francisco, Calif., is now history, and all those who worked so diligently on their various projects and activities can feel a little proud that their efforts were not in vain in helping to produce a successful and smooth running convention.

The opening sessions on both Tuesday and Wednesday by Rudolph Bannow, president of the NAM, and by Admiral Paul D. Stroop, were timely and interesting and set the pace for the sessions that followed throughout the three days.

The social functions seemed to go over very well. Starting with the reception on Monday night, set in the California theme, we had a wine tasting party with the wines from two of California's wineries. On Tuesday night, the theme was the Barbary Coast. Many attending this affair came in the costumes of that era, and for those without costumes, Western hats and other articles were presented to help set the mood.

All totaled, with the wonderful selection of speakers, the good display exhibitions and the social activities, I

University of Minnesota Department of Statistics

The Department of Statistics at the University of Minnesota, which was established during the academic year 1958-59, has supplemented and coordinated the statistical activities of the University—graduate curriculum, research, and consulting.

The Department's organization involves direct appointments as well as joint appointments in mathematics and the sciences.

Following is the current staff of the faculties of statistics:

Statistics—L. Hurwicz, I. Olkin, D. Richter, I. R. Savage, and M. Sobel.

Mathematics—G. Baxter, M. Donsker, B. Lindgren, S. Orey, W. Pruitt, E. Reich, and F. Spitzer.

Agriculture—R. Comstock and C. Gates.

Biostatistics—J. Bearman, J. Berkson, B. Brown, E. Johnson, and R. McHugh.

Business Administration—D. Hastings and J. Neter.

Industrial Engineering—G. McElrath.

believe that this, the first National Convention held on the West Coast, was a very successful, informative, and colorful affair.

On Apr. 11, our dinner meeting was held at the Old Plantation, Los Altos, Calif. The program consisted of a panel discussion on "Reliability and QC — What is the Difference?" The panel consisted of four well known QC people, Lt. Cmdr. Robert W. Smiley, QC Officer, Bureau of Naval Weapons Repr., Sunnyvale, Calif., E. Jack Lancaster, civilian chief, Quality Assurance Division, Air Force Ballistic Missile Center, Inglewood, Calif., Gene Brown, District 17, ASQC Electronic Division Councilor, Lenkurt Electronics, San Carlos, Calif., and A. R. Pennell, QC manager, Motorola, Inc., Scottsdale, Ariz. Moderator for this very lively discussion was Allen Chop, our immediate past chairman, Lockheed Missile and Space Division, Sunnyvale, Calif.

SOUTH BEND-MISHAWAKA . . . On May 19, the section held its annual business meeting at the LaSalle Hotel. Fred DeFerbache, section chairman, presided and reported on the section for the past year. Interesting programs led to increased attendance and membership growth. The program followed a theme of quality in industry. Plant visits were made to local companies representing various products. Plants visited were Torrington Bearing Co., O'Brien Paint Co., U. S. Rubber Co., Dodge Manufacturing Corp., Bendix Products, and Roach-Appleton.

R. C. Carrier, charter member, presented certificates of appreciation to the retiring officers.

Officers installed for the coming year are L. C. Whitcomb, chairman; M. Carlson, secretary, and G. Hughes, treasurer. The following committee appointments were then made: D. L. Correll, program; L. S. Warstler, education; G. DeWachter, membership; C. E. Nordin, publicity; C. A. Makowsky, Saddoris Award; L. C. Magyar, Scrap Book, and J. Gyoles, Midwest Conference representative.

Following the business meeting, Mr. R. Wendt, QC manager, Bendix Products, Missile Division, discussed vendor QC as related to missile reliability. A film "Into the Yonder," which covered the history of missiles and included action photos of the Talos, was shown.

SOUTHERN CONNECTICUT . . . A highly successful season was brought to an equally successful close with the annual Management Night Banquet May 18, at the Stratfield Hotel, Bridgeport, Conn. Dr. J. M. Juran addressed more than 100 members and guests on "Achieving Break-Through in QC." He outlined the steps, and analyzed the factors involved in significantly improving existing quality levels. Dr. Juran stressed the importance of effectively overcoming existing "cultural patterns" of individuals and of organizations.

SYRACUSE . . . It is noteworthy that the Orondaga County School of Technology, in their new program to provide intensive post-high-school technical education to qualify students for technical jobs in industry, has included "Production Planning and Quality Control," as a required course in their curriculum in both the electronics and mechanical technology sequences.

Recognition was given to Dr. M. A. Brumbaugh at the National Convention and Exhibition when he was presented a Certificate of Honorary Membership in ASQC for acknowledged eminent service to QC and to the Society. On behalf of the Syracuse section we extend our sincere congratulations.

Recognition at the Convention was also given to the Syracuse section when it was designated a master section. This citation is awarded annually to sections which have earned Saddoris Award credits amounting to 70 percent or more of those of the winning section.

TENNESSEE . . . Three excellent talks were presented to members and guests at the May 12, "Something for Everyone" meeting. Dr. Allyn Kimball, Oak Ridge

4th ASQC

Workshop-Seminar

Management of Quality Control

STATLER HILTON HOTEL, OCTOBER 6-8

ST. LOUIS, MISSOURI

Industry is giving Quality Control a great deal of emphasis because of its potential for improving product quality while increasing productivity and reducing related costs. This increased scope of quality control has multiplied the responsibilities of the Quality Manager. To help him fulfill his new role, the American Society for Quality Control will conduct a workshop-seminar on Management of Quality Control for the three days of Oct. 6, 7 and 8.

What is the purpose of the workshop seminar? To explore in depth, tested methods of increasing the effectiveness of the quality control program in an industrial plant.

For whom is the program planned? For present and prospective Quality Managers. It is expected that the applicant will have reasonable familiarity with such standard texts as Grant, Feigenbaum, and Juran. To benefit properly from the seminar, the applicant should have a minimum of several years experience with major responsibility for quality.

Who will direct and conduct the program? The Director will be Paul C. Clifford, Professor at Montclair State College. Speakers and Discussion Leaders will include managers of outstanding quality control programs.

Registrants will be sent study materials and case studies prior to the conference. Registration is limited to 75 persons and is complete only on receipt of the registration fee of $125 for non-members, $100 for members, which includes the cost of three lunches.

Your Registration will be acknowledged. A room reservation card for the Statler Hilton Hotel will be enclosed with the acknowledgment.

From 8:30 am on Oct. 6 until 8:00 pm on Oct. 8 registrants will have a full schedule, including evenings. The title WORKSHOP has been chosen deliberately.

Fourth ASQC Workshop - Seminar
American Society for Quality Control
161 West Wisconsin Avenue
Milwaukee 3, Wisconsin

Please make reservations for the fourth ASQC Workshop-Seminar on Management of Quality Control for the following man who satisfies the registration requirements as indicated in the announcement.

Enclosed is our check for $..... to cover..... registrants. Fee—$125 for non-members, $100 for members.

Name .....

Title .....

Company .....

Address .....

City.....Zone No. ....State.....

NOTE: Additional registrations may be made by attaching a list to the above coupon. Please include necessary information for each registrant.

National Laboratory, elucidated "Errors of the Third Kind." The not uncommon errors caused by poor communications between the statistician or QC "expert" and the production personnel, etc., was vividly illustrated by Dr. Kimball.

Dr. L. T. Newman, UCNC's Oak Ridge Gaseous Diffusion Plant, described several types of distributions encountered in life testing and discussed methods for handling these distributions.

"Quality Control in a Missile Manufacturing Plant" was described by Joseph T. Johnson of the Raytheon Corporation plant.

The talks were followed by coffee, doughnuts, and a good discussion.

TUCSON . . . Dr. Martin A. Brumbaugh, director of statistics, Bristol Laboratories, Syracuse, N. Y., an ASQC Fellow, summarized the background and growth of QC at the April meeting of the Tucson section. He sketched the beginnings of ASQC and IQC magazine, of which he was the first editor, and speculated as to our present position on the growth curve.

Prior to the meeting he visited the University of Arizona and talked to students in Fred Ennerson's class in Engineering Statistics and Quality Control. He told them that the QC engineer's stock in trade is a willingness to tackle problems which baffle other engineers, supervisors, and foremen, and the ability to find answers which are usable plantwise. He said that their tool would be the statistical approach, and their greatest asset — confidence.

An honored guest at the meeting was Walter Klontz, chairman of the Phoenix section and one of the new ASQC directors.

Frank Caplan, Westinghouse Corp., spoke to the Tucson section at its regular May dinner meeting on "Electronics Line Experimentation," and emphasized the power of properly designed experiments, and their evaluation in the solution of industrial problems involving numerous variables. Mr. Caplan is a fine speaker with a well defined sense of humor who obviously finds appreciative audiences wherever he goes.

Section officers for the new season are J. W. Loesch, chairman; Eugene L. Fellner, vice chairman; Hugh W. Shea, secretary, and Mark C. Loomer, treasurer.

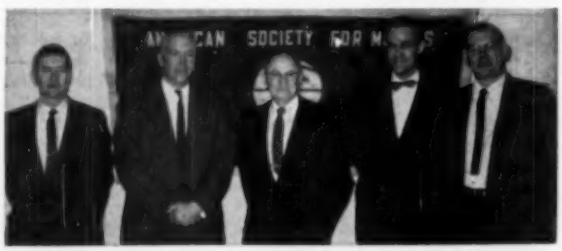
Fred Ennerson spoke at the National Convention and Exhibition on "How Many Dollars are there in Receiving Inspection Costs?"

Also, Tucson section brought home a Master Saddoris Award certificate for the second straight year.

WINDSOR . . . A limited but enthusiastic group turned up at Assumption University to hear the facts on the brewing industry. The speaker for the evening was Frank Roberts, chief chemist, Stron's Brewery, Detroit, Mich. Mr. Roberts supplemented his excellent talk with an interesting color movie, which illustrated the many operations required to produce a good brew. Modern operations require a close contact with production and QC, both in raw material, processing, and the final product. Chairman Roy Mackay conducted an interesting discussion period during which the members and guests attempted to brew up questions that would stump the expert.

Officers for the coming year are Roy Mackay, chairman; Jim McBride, vice chairman; Frank Bederaux-Layne, secretary; Russ Beemer, treasurer, and Ed Harrison, director. Congratulations and good luck, gentlemen!

WINNEBAGO . . . Final meeting of the 1959-60 season was held May 16, at the Elk's Club, Appleton. The program was a problem solving clinic with Dr. C. E. Noble, Kimberly-Clark Corp., Neenah, Wis., as chairman and Dr. Richard Roberts and Alvin G. Powell, both of the Marathon Division of American Can Co., as panel members. For the discussion, members presented problems in the application of QC methods in their fields of operations.



Head table guests at the joint meeting of the Worcester ASQC section and the ASM, which was held Apr. 13, at the Hickory House, are, from the left, Donald J. Coleman, ASM technical chairman; Arthur L. Stowe, ASM chairman; Vincent Lysaght, American Chain and Cable Co., speaker; Richard L. Mark, ASQC section secretary, and Frances B. Olson, ASQC section past chairman.

WORCESTER . . . The May 19 meeting of the Worcester section was Management Night. We were privileged to have Donald L. Price, vice president of marketing, the Norton Co., as guest speaker. Mr. Price gave a very interesting discussion on the relationship of the QC and the marketing functions. He clearly stressed the point that a well trained sales staff is powerless in the present buyers market without a quality product to sell. Mr. Price also had some opinions to offer as to how the sales and QC units could work together more effectively. The interest in the talk was indicated by the numerous questions which were brought up during the discussion period.

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Significant Differences

. . . Albuquerque — **Dr. Bernard Ostle,** Sandia Corp., Albuquerque, N. M., has accepted a full professorship at Arizona University, Tempe, Ariz., effective September 1960. Dr. Ostle, who previously was on the faculty of Montana State College, will teach statistics and operations research in the Division of Engineering at Arizona State.

. . . Allentown-Bethlehem — **Ken Stephens,** Western Electric, our immediate past chairman, spoke at the University of Miami on May 26. His subject was "Quality Control Case Histories."

Dick Zwickl, Western Electric, is our new chairman. He will be assisted by **Tom Kochie,** Atlas Powder, as vice chairman; **Harry Spaulding,** Dixie Cup, as secretary, and **Dan Scrobe,** Western Electric, will continue as treasurer.

. . . Battle Creek-Kalamazoo — **Ralph Anderson,** Engineering Castings Co., was recently chosen by the American Foundrymen's Society to be on their National Sand Committee as a result of considerable sand investigations.

Phillip Harris of Battle Creek has accepted a position in Wheeling, W. Va.

Dr. and Mrs. Fred Beeler missed the annual Ladies night meeting as he was in Philadelphia to present a talk on Quality Control.

. . . Cincinnati — The following Cincinnati section members attended the 1960 Convention and Exhibition in San Francisco, Calif.: **Leon Bass,** past president; **Dave Birch,** national director; **Bill Eilrich,** chairman, Cincinnati section, and **Bob Johnson,** chairman-elect, Cincinnati section.

. . . Cumberland — **Rolland G. Frakes** has assumed the position of QC superintendent at the Celanese Fibers Co., Amcelle plant. Mr. Frakes formerly headed the quality engineering group at the Celco plant.

David A. Powers, formerly QC superintendent at the Celanese Amcelle plant, has assumed the position of extrusion department superintendent.

. . . Dallas-Fort Worth — We welcome **Victor E. Paulos** back to the section. He had been a member of the Waco section since leaving this area some time ago.

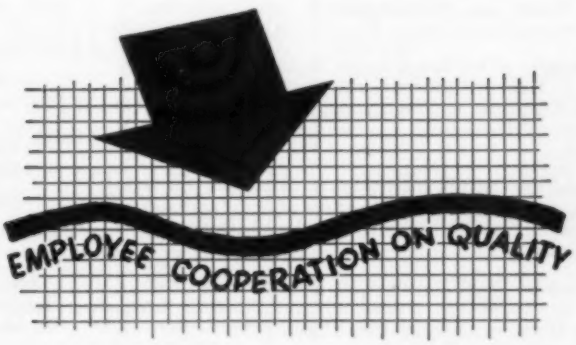
Bill Wortham and **J. Y. McClure** killed two birds with one stone. They took their wives with them to Honolulu, Hawaii, and made a real vacation out of the trip.

Of course, we want to congratulate one of our section's charter members, **J. Y. McClure,** upon his election to the office of ASQC President.

. . . Dayton — **Robert C. Stockert,** Delco Products Division, General Motors Corp., Dayton, Ohio, has been elected section chairman, **James E. Sheehan,** Globe Industries, Inc., Dayton, Ohio, vice chairman; **George H. Kakehashi,** Vernay Laboratories, Inc., Yellow Springs, Ohio, secretary; and **John Condon,** The National Cash Register Co., Dayton, Ohio, treasurer.

. . . Detroit — **Robert Vujovich,** Detroit section program chairman, has been appointed QC director for Fruehauf Trailer Co., according to **Harry E. Foulkrod,** executive vice president, Detroit, Mich. In his new position at the

This Curve is Important too!



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home office, Mr. Vujovich will be responsible for the development, implementation and maintenance of QC programs throughout the plants and branches. He was formerly manager of the Chrysler Corp., Missile Division, quality assurance and reliability programs for the Redstone and Jupiter Weapons systems.

. . . Harrisburg — The May 10 executive meeting was well attended by both the 1959-60 chairmen and the officers for the new season. **Harold Reehling,** program chairman, presented a complete program for committee review and approval. Membership chairman **Wilmer Hineline** outlined his program for acquiring renewals and new members.

Basic, intermediate, and advanced courses are being contemplated by the education chairman, **Herman Singer,** who has sent a questionnaire survey to all members.

Examining committee chairman **Nelson Lupold** is busy reviewing files to determine the eligibility of members for advancement to higher classifications. **Harry Oyler** has been checking the newspapers and broadcasting stations and enlisting their aid. Saddoris chairman **Ann Englehart** is busy finishing current year reports and the starting of a new season scrapbook.

James Skelton will be the National Director. He spoke on the new by-laws which were to be voted upon at the 1960 Convention and Exhibition. Arrangement chairman will be **Kenneth Gainer** and the Technical Societies representative will be **Edward Rubin.** Professionalism post will be ably filled by **George Thomas** and **James Skelton** will advise us on the by-laws.

. . . Huntsville — **Arthur H. Norstrom,** junior past chairman, has been designated AIIE representative on the Huntsville Engineers' Week Council for 1961.

John W. Young Named Vice President North American Aviation, Inc.

In recognition of his professional achievement, ASQC salutes John W. Young, who has been named vice president — quality and logistics, North American Aviation, Inc., Los Angeles, Calif.

A member of the Los Angeles section, Mr. Young holds a B.S. in Mechanical Engineering from Drexel Institute of Technology, 1928, and is a Registered Mechanical Engineer in the State of California.

In addition to his membership in ASQC, he is also an associate fellow, Institute of Aeronautical Sciences, and a member of the American Ordnance Association.

He joined North American Aviation in 1930, where he worked as a designer and Chief of the Power Plant section in the Engineering department until 1953.

Since then he has been:
Director of Quality Control
Corporate Director of Quality Control
Corporate Director of Quality and Logistics

And in February, 1960
Vice President — Quality and Logistics

This is the kind of record that provides living testimony to the principles which ASQC has sponsored as characterizing true professional development in the quality control field. Our congratulations both to John W. Young and North American Aviation.

John D. Beal, Jr., publicity chairman, is currently president of the Northeast Alabama Chapter of the Alabama Society of Professional Engineers.

. . . Lexington — **Don Freeman** attended the ASQC National Convention and Exhibition in San Francisco, California.

. . . Los Angeles — **Steve Kozick** recently joined American Electronics, Inc., as QC manager. He was formerly with Western Design.

Bert Ashby, previously of Summers Gyroscope, is now QC manager of Giannini, Inc.

Ray Primmer, QRA, Inc., has published the first issue of *Plus or Minus,* a four page newspaper of the Los Angeles section's Inspection Group. Under Ray's leadership, many new members of ASQC are finding an outlet for needs in the new group's meetings.

Dr. Paul Leatherman, USAF-BMC, has now assumed chairmanship of the section's Saddoris Award Committee. Mr. Primmer recently joined the management staff of National Astro Laboratories as manager, quality assurance division.

. . . Montreal — **Roger Lessard,** Ecole Polytechnique, has been appointed the Canadian chairman of the Guidance Committee of the Engineering Council for Professional Development.

. . . Northeast Tennessee — On May 26, fifteen persons at Bristol, Tenn., completed a sixteen-week evening course in Elementary Industrial Statistics. The course was sponsored by the section and the State and City School Boards. **Asa Burton,** Elizabethtown, Tenn., presented the course.

J. T. Johnston, section chairman elect and QC manager, Raytheon, Bristol, was commencement day speaker at Steed College of Technology, Johnson City, Tenn., May 27.

The section presented five-hour statistical workshops in QC and statistics at five local colleges in May. The workshops were for senior classmen who are math and physics majors. **J. T. Johnson** of Raytheon and **Hubert Hill, Joe Moriority, Carl Wilson, Tom Bainbridge,** and **Ralph DeBusk** of Tennessee Eastmen, presented the workshops.

In cooperation with seven other Engineering Societies, the section sponsored a lecture by **George R. Atkins,** former member of the U. S. Military Mission to Moscow. Mr. Atkins spoke on "Ten Years in Russia." The talk was given at Tennessee Eastman Auditorium on May 17.

. . . Philadelphia — **W. Ralph Reeves** has been re-elected District 5 director for a two year term which began July 1, 1960.

John C. Saboe has been named a quality control engineer by International Resistance Co., Philadelphia, Pa. Mr. Saboe was formerly with the Budd Co.

. . . Tennessee — Congratulations to **Dave Chambers,** who has just been re-elected ASQC executive secretary.

. . . Tucson — **Raymond E. Dryden, Jr.,** has transferred from the Tucson section to the Georgia section. His new address is 123 Whitehead Circle, Warner Robins, Ga.

Ella Schofield, former Tucson section secretary, has been asked to serve on the ASQC Saddoris Award committee.

. . . Worcester — **Howard Kerans** has been promoted QC engineering supervisor for Timer production at the Ashland, Mass., plant of General Electric Co., as of April 1, 1960.

Classified Advertising

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ASQC Announces

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Harmon, Edward B., Janesville, Wis.
Hommel, Charles D., Middletown, N. J.
McCreary, James, Toronto, Ont., Canada
Moder, Joseph J. Jr., Atlanta, Ga.
Murphy, R. B. New York, N. Y.
Sanches, Ricardo Marle, Mex. D. F., Mex.
Silver, Edward E., Winston Salem, N. C.
Tosic, Dusan, Toronto, Ont., Canada
Wagner, James H., Merriam, Kan.
Wohlbruck, Martin H., Wyomissing, Pa.

(as of July 1, 1960)

Hutinger, Jack H., Jennings, Mo.
Sherman, Morton H., Chicago, Ill.

ADMISSIONS TO THE GRADE OF MEMBER

(as of March 31, 1960)

Ayers, Roger W., Mt. Airy, N. C.
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Bogart, Robert C., Springfield, Mo.
Brunkhart, Don, South Bend, Ind.
Colwell, Wilbert D., Kokomo, Ind.
Conn, William C., Buchanan, Mich.
Craven, Donald, Oshawa, Ont., Canada
Davison, Jack A., Bountiful, Utah
Duenk, Daniel D., Salt Lake City, Utah
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(as of June 30, 1960)

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(as of February 29, 1960)

BAKER, ROBERT W., North Lawerence, Ohio
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(as of March 31, 1960)

BAYNE, RICHARD E., Roxbury, Mass.
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REILLY, DAVID P., Brooklyn, N. Y.
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(as of April 30, 1960)

SRIVASTAVA, SIVA R. W., Lafayette, Ind.
UZUMECKI, RICHARD W., Glen Ellyn, Ill.
WILLIAMS, BURKE, Bay City, Mich.
YOUNG, STANLEY D., Granite City, Ill.
ZAHN, WALTER J., Milwaukee, Wis.

(as of June 30, 1960)

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MOSS, DAVID M., Washington, D. C.
VARLEY, THOMAS C., Arlington, Va.

clinics, conferences, and courses

JULY

. . **25-Aug. 5**—Courses in Programming and Artificial Intelligence and Introduction to the Use of Digital Computers, contact James G. Steagall, University of North Carolina, Extension Division, Box 1050, Chapel Hill, N. C.

AUGUST

. . . **1-19**—1960 Statistical Methods in Industry Course, University of California, Los Angeles campus, five major courses are QC by statistical methods; industrial statistical methods; design and analysis of industrial experiments, industrial reliability, and basic measurements and standards. Participants will have a choice of seven seminar or special laboratory groups and a general lecture series. Instructors include I. W. Burr, Charles Hicks, L. A. Knowler and Robert C. McMaster, contact Edward P. Coleman, Department of Engineering, University of California, Los Angeles 24, Calif.

. . . **7-12**—Second Annual Institute for Practical Research on Operations (second week). Subjects to be covered during the second week will be: inventory control, production scheduling, forecasting analysis, programming-assignment and allocation problems, systems engineering, queuing problems, the digital computer and its practical applications, organizing for change, cultural patterns, industrial diagnostics, operations research analysis of the organization, and practical operations problems. The courses are designed so that a mathematical background is not required. Applications will be accepted whether or not the registrant attended the first week of the course. Contact Richard M. Story, Jr., Box U-41, University of Connecticut, Storrs, Conn.

. . . **7-19**—Third Annual Institute on Missile Technology at the Continuing Education Center, Storrs, Conn., sponsored by the Army Research Office, Office of the Chief of Research and Development—U. S. Army. Session Aug. 13: "Reliability Improvement & Control," by Dorian Shainin. Fee—$325. Contact Albert L. Jeffers, Box U-56, The University of Connecticut, Storrs, Conn.

. . . **8-19**—Ninth Pulp and Paper Statistics Course, Brevard College, Brevard, N. C. Fee for either the basic or advanced section of the course is $275, covering room and board for the two-week period, textbook, and other materials. Both courses will be held concurrently. Contact R. J. Hader, The Institute of Statistics, North Carolina State College, Raleigh, N. C.

. . . **15-25**—Thirteenth Annual Intensive Course in Quality Control by Statistical Methods, a first course for executives and supervisory personnel, practical and mathematically non-technical, instructors will be Fred Beeler, Western Michigan University; C. C. Craig, University of Michigan; E. G. Olds, Carnegie Institute of Technology, and Mason E. Wescott, Rutgers University; contact C. C. Craig, course director, 106 Rackham Bldg., Ann Arbor, Mich.

. . . **22-24**—Fourteenth Alkaline Pulping Conference at the Multnomah Hotel, Portland, Oregon, one of 10 functional conferences for 1960 sponsored by the Technical Association of the Pulp and Paper Industry. Pre-register before Aug. 1. Contact H. O. Teeple, TAPPI, 360 Lexington Ave., New York 17, N. Y.

. . . **24-27**—Forest Biology Conference at the New Washington Hotel, Seattle, Wash., sponsored by the Technical Association of the Pulp and Paper Industry. This Conference will be followed by the World Forestry Conference at the University of Washington, Seattle, Wash. Pre-registration was July 15. Contact TAPPI, 360 Lexington Ave., New York 17, N. Y.

. . . **29-Sept. 5**—The American Mathematical Society will hold its annual Summer Meeting at Michigan State University, East Lansing, Mich., in conjunction with the Mathematical Association of America and the Society for Industrial and Applied Mathematics. Contact the American Mathematical Society, 190 Hope St., Providence 6, R. I.

SEPTEMBER

. . . **1-3**—European Organization for Quality Control Conference, "Controlling Product Quality—Its Value to Industry," Church House, London, contact British Productivity Council (EOQC 1960 Conference), 21, Tothill St., London, S. W. I., England.

. . . **10—Fifteenth Annual Forum, sponsored by the ASQC Greater Detroit section at the Rackham Bldg., University of Michigan, Ann Arbor, Mich. This is a one day forum of unusual and basic QC techniques. Contact Jack Diggs, 31783 Scone, Livonia, Mich.**

. . . **10—Rutger's Quality Control Conference at Rutgers • The State University, New Brunswick, N. J., contact Wm. F. Frey, Bristol Laboratories, Elmsford N. Y.**

. . . **10—Fifth Annual Symposium on Quality Control Methods and Management with the Philadelphia Textile Institute as host, contact Stanley Hart, Esterbrook Pen Co., Camden, N.J.**

. . . **11-23—Eleventh Annual Basic Statistical Quality Control Institute sponsored by the ASQC Southern Connecticut section. Contact Richard M. Story, Jr., Box U-41, University of Connecticut, Storrs, Conn.**

. . . **20-21**—During the coming academic year Carnegie Institute of Technology will offer, in its evening program, two-semester credit courses in experimental design, probability and mathematical statistics, and quality control and industrial statistics. The courses will meet one evening a week, Monday, Wednesday, and Friday evenings respectively, 7:30-10:30 p.m., September, 1960 through May, 1961. Registration for the courses will be Sept. 20-21, from 6:30-9:00 p.m. For further information regarding graduate and undergraduate day courses, write to Edwin G. Olds, Department of Mathematics, Carnegie Institute of Technology, Pittsburgh 13, Pa.

. . . **26-30**—Instrument Society of America Fall Instrument-Automation Conference and Exhibit and 15th Annual Meeting, New York Coliseum, New York, N. Y., contact Director of Technical and Educational Services, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

. . . **27-30**—Exposition and Convention sponsored by the Association of Iron and Steel Engineers at the Cleveland Auditorium, Cleveland, Ohio, contact Association of Iron & Steel Engineers, 1010 Empire Building, Pittsburgh 22, Pa.

. . . **27-29**—Eleventh Annual Testing Conference sponsored by the Technical Association of the Pulp and Paper Industry (TAPPI), Pantlind Hotel, Grand Rapids, Mich. A symposium will be conducted on the testing of "Water—the Most Important Non-Fibrous Raw Material." Contact TAPPI, 11th Testing Conference, Pantlind Hotel, Grand Rapids, Mich.

. . . **30-Oct. 1—Evolutionary Operations (EVOP) Course sponsored jointly by the ASQC Chemical Division and the ASQC South Texas section at the Ben Milam Hotel Houston, Tex. Instructors will be J. Stuart Hunter, University of Wisconsin, and Truman L. Koehler, American Cyanamid Co. Course fee is $100.00, and registration will be limited to 50 persons. Contact Jim C. Deland, Shell Oil Co., P. O. Box 2527, Houston 1, Tex.**

OCTOBER

. . . **4-7**—Tenth Annual Instrument Symposium and Research Equipment Exhibit, National Institutes of Health, Bethesda, Md., sponsored by the Washington sections of the American Association of Clinical Chemists, American Chemical Society, Instrument Society of America, Society of American Bacteriologists, Society for Experimental Biology and Medicine; primary topics include fluorescence, infra-red, activation analysis, ultra-centrifuge, microscopy and electrodes. Contact Herman C. Ellinghausen, Agricultural Research Center, U. S. Department of Agriculture, Beltsville, Md.

. . . **6-8—Fourth ASQC Workshop-Seminar, Statler Hilton Hotel, St. Louis, Mo., Paul C. Clifford, director, professor at Montclair State College. Address inquiries to: Fourth ASQC Workshop-Seminar, ASQC, 161 W. Wisconsin Ave., Milw. 3, Wis.**

. . . **10-12**—16th Annual National Electronics Conference, Sherman Hotel, Chicago, Ill., sponsored by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern and Illinois Universities. Participants incude Iowa State, Notre Dame and Purdue Universities, Michigan State, Wayne State, Michigan and Wisconsin Universities, Electronic Industries Association and Society of Motion Picture and Television Engineers. Contact NEC, 228 N. LaSalle St., Chicago 1, Ill.

. . . **10-13**—Tenth Corrugated Containers Conference, Royal York Hotel, Toronto, Canada, sponsored jointly by the Technical Association

of the Pulp and Paper Industry (TAPPI), New York, and the technical section of the Canadian Pulp and Paper Association (CPPA), Montreal. This will be the first such conference to be held in Canada. Contact H. O. Teeple, TAPPI, 360 Lexington Ave., New York 17, N.Y.

. . . 10-15—Reliability Training Conference at the Lake Texhoma Lodge near Kingston, Okla., north of the Dallas-Fort Worth area, sponsored by the ASQC Electronics Division and the PGRQC of IRE, contact Art Roddey, registration chairman, Institute for Defense Analysis, The Pentagon, Washington 25, D. C.

. . . 14-15—Fifteenth Midwest Quality Control Conference, Wichita, Kans., contact Ralph D. Humphries, Cessna Aircraft, Wichita, Kans.

. . . 19-21—Fourteenth New England Quality Control Conference, Hotel Bancroft, Worcester, Mass., contact Francis B. Olson, Norton Company, New Bond St., Worcester, Mass.

. . . 20-22—Seventh International Meeting, Institute of Management Sciences, for administrators and scientists in the field of management, Hotel Roosevelt, New York, N. Y. Registration fees—members $15, non-members $20, students $5. Contact James Townsend, 30 East 42nd St., New York 17, N. Y.

. . . 23-27—15th Engineering Conference, Robert Meyer Hotel, Jacksonville, Fla., sponsored by the Technical Association of the Pulp and Paper Industry (TAPPI), contact Eleanor Ney Wark, Technical Association of the Pulp and Paper Industry, 360 Lexington Ave., New York 17, N. Y.

. . . 31-Nov. 5—One-week course in packaging management, Hotel Astor, New York City, sponsored by the American Management Association. Contact American Management Association, 1515 Broadway, Times Square, New York 36, New York.

NOVEMBER

. . . 3-4—Fourth Technical Conference, Chicago, Ill., sponsored by the ASQC Chemical Division, contact Karl J. Bauer, Abbott Laboratories, North Chicago, Ill.

. . . 11-12—Eighth Annual Aircraft and Missiles Division Conference and Middle Atlantic Conference, Lord Baltimore Hotel, Baltimore, Md., contact Stanley Kalin, Dept. 251, Bendix Radio Corp., Baltimore 4, Md.

. . . 15-16—Symposium on Engineering Applications of Probability and Random Function Theory, Lafayette, Ind., sponsored by Purdue University. The symposium will stress applications of probability and random function theory Contact J. L. Bogdanoff or F. Kozin, Symposium co-chairmen, Division of Engineering Science, Purdue University, Lafayette, Ind.

DECEMBER

. . . 13-15—Tenth Annual Eastern Joint Computer Conference (EJCC), Hotel New Yorker and Manhattan Center, sponsored by the National Joint Computer Committee, which consists of representatives of the Institute of Radio Engineers, the American Institute of Electrical Engineers, and the Association for Computing Machinery. Abstracts of technical papers proposed for the conference should be submitted by Aug. 13, to the technical program chairman, Elmer C. Kubie, Computer Usage Co., Inc., 18 East 41st St., N. Y. 17, N. Y. Subject matter should concern recent achievements or techniques in the design and use of computing equipment. Contact P.O. Box 2580, Grand Central Station, N. Y. 17, N. Y.

JANUARY

. . . 9-11—Seventh National Symposium on Reliability and QC, Bellevue-Stratford Hotel, Philadelphia, Pa., sponsored by the IRE, AIEE, EIA, and ASQC. Contact R. L. Schwerin, vice chairman, publicity committee, Emerson Radio and Phonograph Corp., Jersey City 2, N. J.

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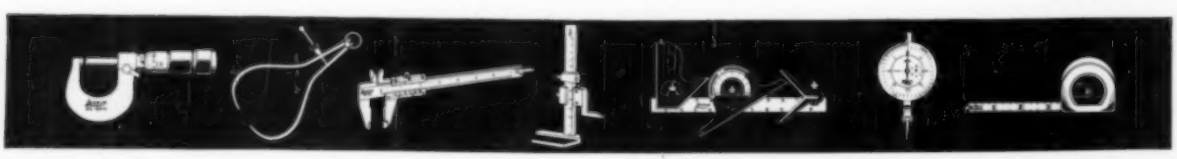
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